te technical note techi

Aviation Weather Research Products (AWRP) Evaluation Report

William Benner
Thomas Carty

April 1999

DOT/FAA/CT-TN98/12

Document is on file at the William J. Hughes Technical Center Library, Atlantic City International Airport, NJ 08405

DTIC QUALITY INSPECTED 4

U.S. Department of Transportation
Federal Aviation Administration
William J. Hughes Technical Center
Atlantic City International Airport, NJ 08405

19990916 005

DISTRIBUTION STATEMENT A
Approved for Public Release
Distribution Unlimited

NOTICE

This document is disseminated under the sponsorship of the U.S. Department of Transportation in the interest of information exchange. The United States Government assumes no liability for the contents or use thereof.

The United States Government does not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the objective of this report.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/CT-TN98/12		

4. Title and Subtitle	5. Report Date
Aviation Weather Research Products (AWRP) Evaluation Report	April, 1999
	6. Performing Organization Code ACT-320

7. Author(s)	8. Performing Organization Report No.
William Benner, Thomas Carty; Starr Fox McGettigan, Raytheon Systems Co.; Danny Sims, Systems Resources Corporation.	DOT/FAA/CT-TN98/12

9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
U.S. Department of Transportation Federal Aviation Administration William J. Hughes Technical Center Atlantic City International Airport, NJ 08405	11. Contract or Grant No.
	13. Type of Report and Period Covered Technical Note
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration William J. Hughes Technical Center Atlantic City International Airport, NJ 08405	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This report describes the evaluation of the Aviation Weather Research Products (AWRP) conducted by ACT-320 at the Federal Aviation Administration (FAA) Technical Center from July 17 to August 25, 1995.

The AWRP software produces graphical aviation weather products specifically intended for use by nonmeteorologists such as Air Route Traffic Control Center (ARTCC) Traffic Management Unit (TMU) Coordinators and Automated Flight Service Station Specialists (AFSS).

The AWRP evaluation was conducted from a Human Factors, Meteorological, and System Administration perspective. The Human Factors portion of the evaluation assessed AWRP user-system interface and the AWRP User's Guide in addition to determining the extent to which the AWRP met the job task and weather information needs of controllers and specialists. The Meteorological portion of the evaluation determined the amount of meteorological interpretation needed for the individual products, whether products showed improvement over existing operational products, and meteorological consistency within and between products. The System Administration portion of the evaluation addressed the usability and effectiveness of the AWRP installation and system management documents.

Although the evaluation identified improvements over current systems, several additional improvements would have to be made to the AWRP in order to consider the products for potential incorporation into FAA systems. This document defines the areas needing improvement.

17. Key Words	18. Distribution Statement
Aviation Weather Research Graphical Weather Systems Human Factors Meteorological Evaluation	Document is on file at the William J. Hughes Technical Center Library, Atlantic City International Airport, NJ 08405

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	175	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

TABLE OF CONTENTS

	Page
EXECUTIVE SUMMARY	vi
1. INTRODUCTION	1
1.1 Purpose	2
1.2 Scope	2
2. REFERENCE DOCUMENTS	3
3. SYSTEM DESCRIPTION	4
3.1 Mission Review	4
3.2 System Configuration	4
3.3 Interfaces	4
4. EVALUATION DESCRIPTION	4
4.1 Schedule and Locations	4
4.2 Participants	5
4.3 Specialized Evaluation Equipment	5
4.4 Evaluation Objectives and Criteria	5
4.5 Evaluation Description	8
4.6 Data Collection and Analysis Method	11
5. RESULTS AND DISCUSSION	11
5.1 Human Factors Evaluation Results and Discussion	11
5.2 Meteorological Results and Discussion	51
5.3 System Administrator Results and Discussion	66
6. CONCLUSIONS	67
6.1 Human Factors Conclusions	67
6.2 Meteorological Conclusions	70
6.3 System Administrator Conclusions	72
7. RECOMMENDATIONS	72
8. ACRONYMS	74
APPENDIX A	

LIST OF ILLUSTRATIONS

Figure		Page
1	Obscuration of Station Identifier in Flight Category Product	14
2	Winds Aloft Color Contrast	23
3	Lightning Strike Color Contrast	24
4	Icing and Mountain Obscuration AIRMET Color Contrast	27
5	Positional Locator Window	32
6	AWRP Area Motion and Convective SIGMET Motion	54
7	Icing Potential	58

LIST OF TABLES

Table		Page
1	Guidelines for Designing User Interface Software	13
2	AFOTEC System Usability Guidelines	16
3	MIL-STD 1472D Standards	25
4	Air Traffic User Working Group Meeting Requirements	34
5	Air Traffic User Working Group Color Requirements	36
6	1993 Demval Requirements	38
7	Preflight Specialist's Weather Information Requirements	44
8	Inflight Specialist's Weather Information Requirements	45

9	EFAS Specialist's Weather Information Requirements	47
10	ARTCC TMC's Weather Information Requirements	48
11	Meteorological Interpretation of AWRP	51
12	Meteorological Consistency Results	63

EXECUTIVE SUMMARY

This report describes the evaluation of the Aviation Weather Research Products (AWRP) conducted by ACT-320 at the Federal Aviation Administration (FAA) Technical Center from July 17 to August 25, 1995. Specific results, conclusions, and recommendations for the evaluation are detailed within the report.

The AWRP software produces graphical aviation weather products specifically intended for use by nonmeteorologists such as Air Route Traffic Control Center (ARTCC) Traffic Management Unit (TMU) Coordinators and Automated Flight Service Station (AFSS) Specialists. The products are created using National Weather Service (NWS) computer forecasted gridded data, radar data, and surface observations. A precursor to the AWRP, the Aviation Weather Products Generator (AWPG), provided specific product recommendations and user requests to the format and display of the AWRP.

While the AWRP is not a formal FAA acquisition, the products are designed to be coupled with existing and future weather systems. The products are expected to significantly improve the accuracy and timeliness of current and forecasted aviation weather information. Thus, the purpose of the evaluation was to identify AWRP concepts and techniques that demonstrate utility and which can be incorporated into FAA acquisition programs and commercial vendor supplied weather systems.

The AWRP evaluation was conducted from a Human Factors, Meteorological, and System Administration perspective. The Human Factors portion of the evaluation assessed AWRP user-system interface and the AWRP User's Guide in addition to determining the extent to which the AWRP met the job task and weather information needs of controllers and specialists. The Meteorological portion of the evaluation determined the amount of meteorological interpretation needed for the individual products, whether products showed improvement over existing operational products, and meteorological consistency within and between products. The System Administration portion of the evaluation addressed the usability and effectiveness of the AWRP installation and system management documents.

Although the evaluation identified improvements over current systems, several additional improvements would have to be made to the AWRP in order to consider the products for potential incorporation into FAA systems. These include:

a. improvements to the AWRP display and interface according to human factors guidelines and standards;

b. incorporation of all reasonable user requests;

c. addition of all required weather information;

d. resolution of interpretation issues concerning conflicting information;

e. improvements in meteorological consistency; and

f. improvements to the system administration documentation.

Despite the discrepancies noted, the AWRP has the potential to provide controllers and specialists with much needed improvements in the area of aviation weather information. ACT-320 strongly recommends the continued development of aviation weather graphical products and the underlying science. Additionally, if further development of the AWRP is going to be conducted, it is recommended that suggested improvements be made to the display, interface, User's Guide, system administration documentation, and meteorological interpretation and consistency. However, consideration should be given to off-the-shelf commercial weather products or the development of weather graphics by commercial vendors.

1. INTRODUCTION.

The Federal Aviation Administration (FAA) Weather Processors Integrated Product Team manages research and development of aviation weather products. Products and related science are developed by several laboratories such as the National Center for Atmospheric Research (NCAR), the Forecast Systems Laboratory (FSL), and Lincoln Laboratories among others. When these weather products are coupled with existing and future weather systems, they are expected to significantly improve the accuracy and timeliness of current and forecasted weather information available to Automated Flight Service Stations (AFSSs), Air Route Traffic Control Centers (ARTCCs), and private aviation weather users.

In the summer of 1993, the Aviation Weather Products Generator (AWPG) underwent an initial product Demonstration and Evaluation (the 1993 Demval). The 1993 Demval was conducted by the FAA Technical Center and NCAR. The 1993 Demval yielded specific product recommendations along with general conclusions and recommendations to tailor aviation weather products and functions to user group needs.

In addition to user feedback gathered during the 1993 Demval, the Air Traffic User Working Group (ATUWG) and a Job Task Analysis (JTA) completed by ACT-320 have provided operationally based information requirements for use in the review of the Aviation Weather Research (AWR) graphical weather products. ATUWG consists of controllers and specialists who are representative of operational air traffic users. Members of the ATUWG met on a semiannual basis to review the progress of the Aviation Weather Research Products (AWRP) and provide feedback.

The JTA effort was conducted by ACT-320 to better understand the use of weather products by Traffic Management Coordinators (TMCs) at ARTCC Traffic Management Units (TMU) and AFSS Specialists. The JTA was intended to provide baseline information regarding current AFSS and ARTCC TMU job task and weather information needs for the development of AWPG graphical weather products. JTA results outline how specific weather information is obtained, why

it is obtained, and the format of the weather information. These results can be used to review graphical weather products in order to identify how well the products satisfy job task requirements.

A successor to the AWPG, the AWR graphical weather products include various weather products resulting from aviation weather research. These products are created using National Weather Service (NWS) computer forecasted gridded data, radar data, and surface observations. The AWR graphical weather products software produces user-specific aviation weather products specifically intended for use by nonmeteorologists. Potential users of the aviation weather products include ARTCC TMU coordinators, AFSS Specialists, and airport operations personnel.

While the AWR graphical weather products are not designated as a formal FAA acquisition, the concepts and techniques identified as having utility can be incorporated into FAA acquisition programs such as the Weather and Radar Processor (WARP), the Integrated Terminal Weather System (ITWS), and into commercial vendor supplied weather systems under Cooperative Research and Development Agreements (CRDAs). The AWR graphical weather products are the focus of this evaluation report.

1.1 PURPOSE.

The purpose of this report is to document results of the AWR graphical weather products evaluation. The evaluation was conducted from human factors, meteorological, and system administration perspectives. Since the developer (NCAR) was not bound by FAA design requirements, the recommendations provided herein are intended as feedback for the development of future graphical weather products.

1.2 SCOPE.

For the remainder of this report, the AWR graphical weather products will be referred to as the Aviation Weather Research Products (AWRP). It is important to note that the AWRP is not a system, but a collection of products. This report summarizes the evaluation of the weather products individually, as well as collectively. The report is written using FAA-STD-024B as a guideline. The contents of this report include a summary of the AWRP configuration, evaluation descriptions, results,

conclusions, and finally, recommendations for the AWRP and graphical weather systems in general.

2. REFERENCE DOCUMENTS.

FAA-STD-024B	FAA Standard 024B, Content and Format Requirements for the Preparation of Test and Evaluation Documentation, August 22, 1994.
ESD-TR-86-278	Guidelines for Designing User Interface Software, August 1986.
AFOTEC Pamphlet 99-102	Air Force Operational Test and Evaluation Center (AFOTEC) Software Usability Evaluation Guide, Volume 4, June 1994.
MIL-STD-1472D	Military Standard 1472D, Human Engineering Guidelines, March 14, 1989.
FAA 7210.3	Facility Operation and Administration, September 16, 1993.
FAA 7110.10	Flight Service, September 16, 1993.
FAA 7110.65	Air Traffic Control, September 16, 1993.
FAA ORDER 7032.15	Air Traffic Weather Needs and Requirements Report, October 5, 1994.
FCM-P27-1992	National Aviation Weather Program Plan, September, 1992.
	FAA ACT-320 1994 Job Task Analysis (JTA) Report, March 1995, DRAFT.
	1993 FAA Technical Center Summer Demonstration Report of the AWPG, October 20, 1993.
	AWRP Documentation -- AWPG User's Guide, March 1995.

AWRP Documentation -- AWRP Installation Executable Only, March 1995.

AWRP Documentation -- AWRP Installation Source Code, March 1995.

AWRP Documentation -- AWRP Live System Management, March 1995.

3. SYSTEM DESCRIPTION.

3.1 MISSION REVIEW.

The AWRP is not part of an FAA acquisition program. The evaluated displays are the result of aviation weather related research coupled with user identified needs. Concepts and techniques of the AWRP identified as having utility should be considered for incorporation into existing and future graphical weather systems, such as WARP and ITWS so that they might better satisfy their respective mission requirements.

3.2 SYSTEM CONFIGURATION.

The platform used for the display of products consisted of AWRP software, a Sun Sparc20 Workstation, a Cisco router, and a Data Service Unit/Channel Service Unit (DSU/CSU) connected to a 56-kilobytes (Kb) per second dedicated line. Computer forecast data, NWS Family of Services (FOS), and vendor supplied radar mosaic and lightning data are collected at NCAR and forwarded to the FAA Technical Center via the dedicated line. The AWRP software converts the data into graphical and textual weather products.

3.3 INTERFACES.

Not applicable.

4. EVALUATION DESCRIPTION.

4.1 SCHEDULE AND LOCATIONS.

The AWRP evaluation was performed from July 17 to August 25,

1995, in a nonoperational environment at the FAA Technical Center Aviation Weather Facility. In addition, informal evaluations and troubleshooting were conducted on an on-going basis since the March 1995 release of the software.

4.2 PARTICIPANTS.

Personnel from the following organizations conducted and supported the AWRP evaluation:

Organization	Role
ACT-320	Test Director and Evaluators
NCAR	Technical Support

4.3 SPECIALIZED EVALUATION EQUIPMENT.

No specialized test equipment was required.

4.4 EVALUATION OBJECTIVES AND CRITERIA.

4.4.1 Human Factors Objectives.

The objectives of the human factors evaluation were as follows:

a. To assess the AWRP user-system interface;

b. To assess the AWRP User's Guide; and

c. To determine if the AWRP meets the job task and weather information needs of controllers and specialists.

4.4.2 Human Factors Evaluation Criteria.

Human factors issues associated with the AWRP were determined by an independent Human Factors Specialist familiar with air traffic functions. Criteria for the human factors aspects of the evaluation are discussed in the following paragraphs.

4.4.2.1 User-System Interface Guidelines.

Information from human factors standards and interface documents (i.e., Guidelines for Designing User Interface Software, AFOTEC

Software Usability Evaluation Guide, and Military Standard 1472D) were used to guide the evaluation of the user-system interface; specifically, screen layout, menu structure, color coding, symbology, and data entry. The success criteria for this portion of the evaluation were in general agreement with the guidelines listed in paragraph 5.1.1.1.

The AWRP was not designed specifically to these guidelines. However, the guidelines are industry accepted standards that characterize effective user-interface design.

4.4.2.2 AWRP User's Guide.

The AWRP User's Guide was assessed according to its accuracy regarding system performance and its effectiveness in describing product use. The success criteria were accurate explanation of interface devices, satisfactory product and function operation, and appropriate error messages.

4.4.2.3 Job Task and Weather Information Needs.

Job task and weather information needs determined from the JTA, ATUWG meetings, and the 1993 Demval were used for comparisons to assess the extent to which the AWRP met user needs. The success criteria for this assessment were satisfaction of the task and information needs as identified in the JTA, ATUWG meetings, and the 1993 Demval.

4.4.3 Meteorological Objectives.

The objectives of the meteorological evaluation were as follows:

a. To determine the amount of meteorological interpretation needed for the individual products;

b. To determine whether, and to what extent, the products show improvement over existing operational products; and

c. To determine the meteorological consistency both within and between products.

4.4.4 Meteorological Evaluation Criteria.

The meteorological evaluation was conducted by an independent meteorologist familiar with air traffic functions. A product-by-product assessment was performed that addressed whether too much or too little information was presented for air traffic personnel, the meteorological symbolism used in the products, and compliance with generally accepted meteorological practices.

Improvements over existing products were determined by reviewing a subset of current AFSS weather products and their use, then directly comparing the AWRP to the AFSS products. Current AFSS weather products were reviewed at the Millville, New Jersey, AFSS prior to the official start of the AWRP evaluation.

Meteorological consistency was determined by comparison of graphical and textual portions of the AWRP to ensure that graphics agree with accompanying text. Consistency was also determined by comparison of products showing related phenomena over the same geographical region. Guidelines for meteorological consistency are listed in paragraph 5.2.3.

The meteorological success criteria were:

a. Limited or no meteorological interpretation needed;

b. Improvement over current operational AFSS weather products; and

c. Compliance with the guidelines in paragraph 5.2.3.

4.4.5 System Administrator Objectives.

The objectives of the system administration evaluation were to determine if the AWRP installation and system management documents were usable and effectively described installation and system management procedures.

4.4.6 Evaluation Criteria.

The AWRP installation and system management documents were assessed according to their accuracy and effectiveness regarding installation and system management procedures.

4.5 EVALUATION DESCRIPTION.

4.5.1 Human Factors Evaluation Description.

The human factors evaluation was conducted in two stages. The first consisted of a general review based on user-system interface standards and product improvements which were incorporated following the 1993 Demval. The second stage was a more specific analysis based on user needs, job tasks, and how products would work in an operational setting. Each evaluation stage is discussed below.

4.5.1.1 General Review Stage.

This stage of the evaluation compared product and user-system interface characteristics with the guidelines listed in paragraph 5.1.1. The guidelines focus on the use of the interface in the context of user tasks, display concepts (e.g., color coding, icons, and functionality), and information format (e.g., interpretability, and workload). Each product was evaluated in order to determine how well the interface and display concepts met the guidelines.

An additional component of the general review stage was the assessment of the User's Guide. The evaluator determined if the following areas were described accurately and concisely:

a. Interface devices (e.g., mouse and trackball);

b. Product operation and output; and

c. Function (e.g., zoom, pan, text, route select, etc...) operation and output.

The User's Guide was also reviewed to ensure that error messages were defined and possible solutions were outlined.

4.5.1.2 Operational Analysis Stage.

4.5.1.2.1 JTA Background.

The JTA report was developed internally by ACT-320 in an effort to better understand the weather requirements of Traffic

Management Coordinators at ARTCC TMUs and AFSS Specialists. This information was to be provided to NCAR as feedback for the development of AWR graphical weather products. However, AWRP developers (NCAR) were not required to utilize JTA information and recommendations in their design of the AWRP.

The JTA was developed in two stages. During the first stage, a research effort was conducted in which several reference reports (FAA 7210.3, FAA 7110.10, FAA 7110.65, Air Traffic Weather Needs and Requirements Report, and National Aviation Weather Program Plan) were used to develop task lists for AFSS Specialists and TMCs. A list of required information was developed for any task involving weather assessment and dissemination.

Following the compilation of job task lists and weather information requirements, job tasks were depicted using flow charts. Corresponding weather information requirements were outlined in tables. Weather tables were then further expanded to include the process by which the required information was obtained. Process information included sources, interpretation, format, and utility of the weather data associated with the job tasks.

The second stage of the JTA involved confirming all information compiled during the first stage. Confirmation was accomplished by comparing information contained in the flowcharts and tables to observe job task and weather information requirements in an operational setting.

4.5.1.2.2 ATUWG and 1993 Demval Background.

During the development of the AWRP, the ATUWG provided operationally based feedback on AWRP. Desired product improvements, as determined from the ATUWG meetings and the 1993 Demval, were used as representative examples of features needed to provide or improve operational utility.

4.5.1.2.3 Evaluation Approach.

During the operational analysis, the AWRP was compared to user requests from the ATUWG, the 1993 Demval results, and recommendations from the JTA report. Compliance with user requests and recommendations was scored using a binary approach

(i.e., request/recommendation met or not met). In addition, user needs not addressed at all by the AWRP were identified. The results of the comparison provide insight to the probable operational utility of the individual products. Requests from the ATUWG and 1993 Demval are discussed in paragraph 5.1.2.1. Information requirements for AFSS Specialists and ARTCC TMCs are discussed in paragraph 5.1.2.2. Complete JTA flowcharts and weather information tables are listed in appendix A.

4.5.2 Meteorological Evaluation Description.

4.5.2.1 Meteorological Interpretation.

Meteorological interpretation was determined by observing the AWRP and determining whether the products were clearly understandable or if interpretation was needed. The level of interpretation was rated on a numerical scale of 1 to 10 with 1 requiring no interpretation and 10 requiring much interpretation.

4.5.2.2 Improvement Over Current Products.

Improvement over current AFSS weather products was determined by comparing the AWRP to existing operational products. The comparison was not intended as a verification of the products or the weather data used as input; rather, the comparison concentrated on the format, timeliness, and amount of meteorological information presented. Existing operational products were viewed at the Millville, New Jersey, AFSS. While products may vary between AFSSs, the products reviewed at the Millville AFSS are considered representative of current operational capabilities. After a thorough review of current AFSS weather products, the AWRP was assessed and the level of improvement contributed by the AWRP was determined.

4.5.2.3 Meteorological Consistency.

The AWRP was evaluated for meteorological consistency between graphics and text. In addition, consistency between individual products showing related phenomena over the same geographical region was evaluated. Consistency was evaluated in order to ensure that conflicting information was not presented within and between products. Consistency was scored using a binary method (i.e., consistency met or not met).

4.5.3 System Administrator Evaluation Description.

The following AWRP documents were evaluated to ensure accuracy and ease of understanding of procedures and information:

a. AWRP Installation - Executable Code,
b. AWRP Installation - Source Code, and
c. AWRP Live System Management.

Using the vendor supplied documentation, the system administrator performed system installation and operation.

4.6 DATA COLLECTION AND ANALYSIS METHOD.

During the human factors portion of the evaluation, data was recorded and summarized using guidelines and standards tables. Problems with the User's Guide and comparisons to the JTA were noted and summarized as well. For the meteorological portion of the evaluation, interpretation issues were recorded using a 10-point scale and summarized.

5. RESULTS AND DISCUSSION.

5.1 HUMAN FACTORS EVALUATION RESULTS AND DISCUSSION.

This section will present the results of the human factors evaluation. The evaluation was conducted in two stages; therefore, results will be discussed separately for each stage.

5.1.1 General Review Stage.

This section will present the results from the general review portion of the evaluation. Specifically, it will discuss the comparison of AWR product and user-system interface characteristics to human factors standards and guidelines. In addition, the assessment of the User's Guide will be discussed.

5.1.1.1 User-System Interface Guidelines.

The AWRP interface was evaluated using Guidelines for Designing User Interface Software, AFOTEC Software Usability Evaluation Guide, and MIL-STD 1472D. A subset of interface design guidelines directly relating to the AWRP interface were

identified from these references. AWRP interface characteristics were then compared to these guidelines. The results from these comparisons are discussed in the following paragraphs.

5.1.1.1.1 Guidelines for Designing User Interface Software.

Table 1 presents the results of the comparison of the AWRP interface characteristics to design guidelines from Guidelines for Designing User Interface Software.

Design guidelines stated in table 1 and not met by the AWRP are as follows:

a. Guideline 4: Standard labeling is not currently used on the AWRP display. Product buttons are labeled using Unix-style language (e.g., Flt_Cat and Frz_Level) as opposed to full product names. Additionally, some labels are abbreviated (e.g., Show Vert and Posloc). Buttons should be labeled in standard language using as few abbreviations as possible.

b. Guideline 5: Airport labels on the Flight Category product are considered critical data especially in congested areas. As a user zooms in, the flight category dots obscure the identifiers making it difficult to accurately identify the stations. Figure 1 illustrates this problem. Airport identifiers should be highlighted so stations can be identified.

c. Guideline 6: A definition index for flight categories is not available on the AWRP display. Additionally, an obscuration symbol index is not available. This information should be included in the on-line help system. Provide a definition index in the on-line help system for both flight categories and obscuration symbols. Also, provide obscuration symbol index in the User's Guide.

d. Guideline 11: Looping or animation is not available for dynamic products (e.g., Radar Mosaic and Lightning). It is difficult to effectively use dynamic products without the benefit of trend information that is usually evident during product animation. Looping should be available for dynamic products.

TABLE 1. GUIDELINES FOR DESIGNING USER INTERFACE SOFTWARE

GUIDELINE	MET?	COMMENTS
1. Use graphics for spatial and temporal information.	Yes	
2. Use graphics for quick scanning and data comparisons.	Yes	
3. Use graphics when users must monitor changing data.	Yes	
4. Use standard format and labeling for all graphic products.	No	Unix-style language should not be used to label buttons (Flt_Cat).
5. Highlight features that show critical data.	No	Flight Category dots obscure airport text.
6. Include reference index for data comparisons to critical values.	No	No reference is available for Flight Categories or visibility obstruction.
7. Annotate graphics with text when precise readings are necessary.	Yes	Good examples: Winds Aloft, Temperature, Area and Cell Motion.
8. Format annotations consistently in relation to graphic elements.	Yes	
9. Display all labels in normal reading orientation.	Yes	
10. Design icons to resemble objects or processes they represent.	Yes	
11. Use animation for dynamic information (i.e., looping).	No	Looping is not available.
12. Establish standard meanings for symbols.	Yes	Good Examples: Flight Category, Wind Barbs.

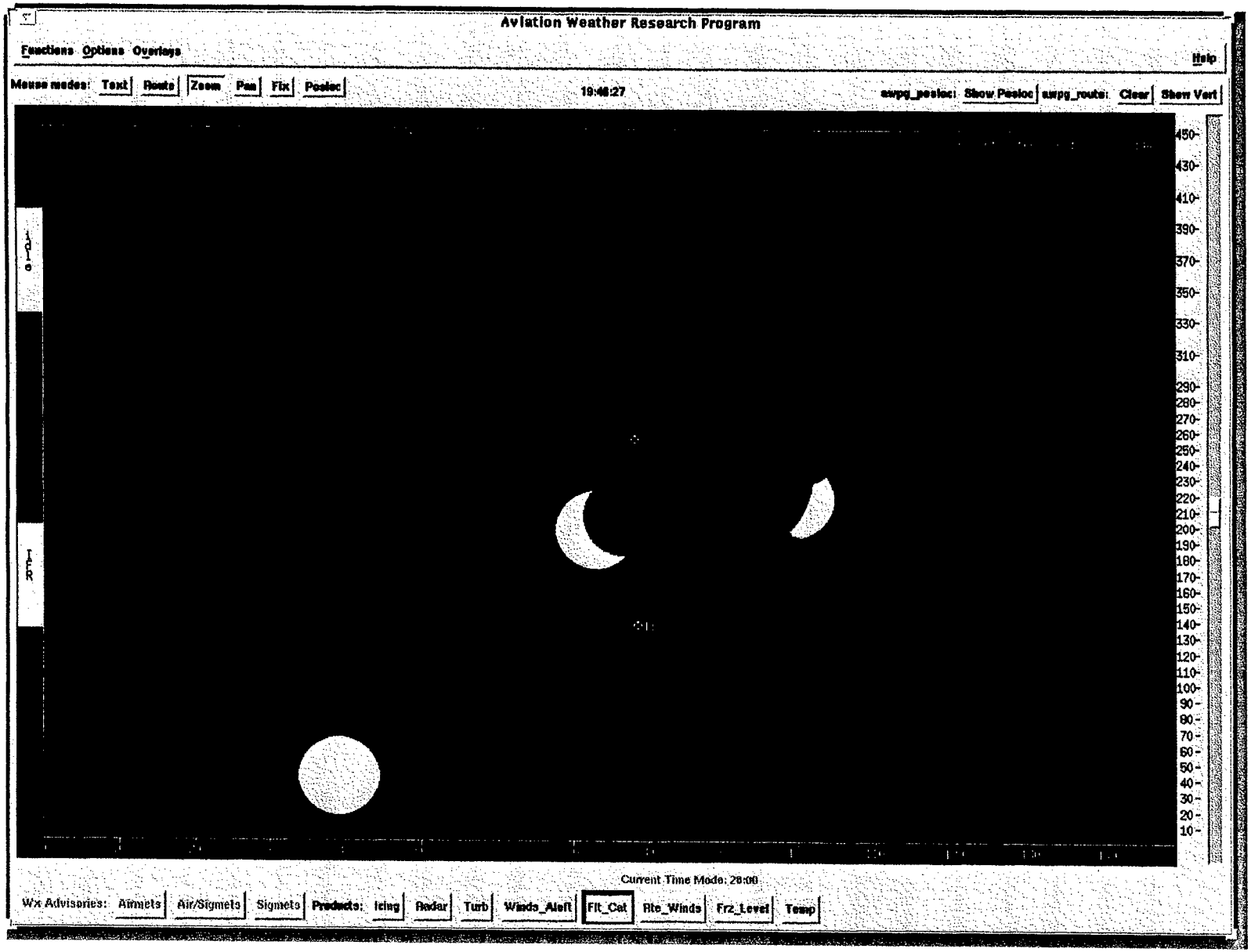


FIGURE 1. OBSCURATION OF STATION IDENTIFIER IN FLIGHT CATEGORY PRODUCT

5.1.1.1.2 AFOTEC Software Usability Evaluation Guide.

Table 2 presents the results of the comparison of the AWRP interface characteristics to a subset of AFOTEC design guidelines.

Design guidelines stated in table 2 not met by the AWRP are as follows:

a. Guideline 1: In the Positional Locator mode, data entry requires a fixed format; however, the system does not prompt for this fixed format. If the user enters the data incorrectly, the system only beeps and offers no indication as to why the entry is wrong. The Positional Locator window should provide a fixed field in which data is entered. If data is entered incorrectly, a message box should prompt the user regarding the correct format for data entry.

b. Guideline 6: Data entered in the Positional Locator window is very difficult to edit. While in the hollow box, the backspace or delete keys do not work to fix the entry. Editing data should be simple. Instructions regarding data editing should appear in both on-line help and the User's Guide.

c. Guideline 8: While the system does have a busy indicator, it does not always appear immediately following user inputs. In the text mode, the busy indicator appears several seconds after a request. Since the user thinks the input did not register, several more clicks may be entered until feedback is received. If the user has entered more than one request, several copies of the requested text will appear in the window. The busy indicator should appear immediately following user input.

d. Guideline 9: The AWRP has no error messages. For instance, in the Positional Locator mode, if the user enters data incorrectly, the system simply beeps. The user does not know why the system beeped or how to fix the problem. Error messages should be incorporated which clearly identify the problem and a potential solution.

TABLE 2. AFOTEC SYSTEM USABILITY GUIDELINES

GUIDELINE	MET?	COMMENTS
1. System prompts when fixed or maximum data entry is required.	No	Data entry in the Positional Locator mode allows user to enter data in any format; yet, data must be entered in XXX/XXX/XXX.
2. Cursor is easy to locate.	Yes	
3. Data fields are adequately labeled.	Yes	
4. Data entry is user-paced.	Yes	
5. System minimizes keyboard and keypad data entry.	Yes	
6. Text inputs are easy to edit.	No	Data entry for Positional Locator is difficult to edit.
7. The user is not required to enter data already available to system.	Yes	
8. System provides quick, positive feedback after inputs.	No	Busy indicator does not immediately follow text input.
9. Error messages are clear and succinct.	No	AWRP has no error messages.
10. It is clear what mode the user is in.	No	Modes do not always disengage. Two mode buttons can be depressed.

TABLE 2. AFOTEC SYSTEM USABILITY GUIDELINES (Continued)

GUIDLINE	MET?	COMMENTS
11. Menus and menu selection options are appropriately labeled.	Yes	
12. System defaults are set on the most frequently used options.	No	AWRP defaults to Icing Product. Airmets or Radar screen would be more appropriate.
13. A processing or working message appears while system is working.	No	Busy indicator does not accurately reflect system state.
14. Menu selection options are organized by function and order.	No	Mouse modes should be organized according to most frequently used. Zoom and pan would most likely be most frequently used.
15. Menu options are consistent in wording, order, and format.	Yes	
16. Wording of menu options is consistent with functions they control.	Yes	
17. Menu options are easy to locate with menu hierarchy.	Yes	
18. Inactive menu selections de-emphasized on display.	Yes	
19. It is easy to move along different levels of menu.	Yes	

TABLE 2. AFOTEC SYSTEM USABILITY GUIDELINES (Continued)

GUIDLINE	MET?	COMMENTS
20. The system minimizes shifting from mouse to keyboard input.	Yes	
21. The amount of data presented on the screen is appropriate.	Yes	It is controlled by the number of overlays utilized by the user.
22. Data is displayed in a logical manner.	Yes	
23. In any display, all necessary data are display.	Yes	
24. Display update is fast enough to keep up with user inputs.	No	For operational setting, text is not displayed fast enough.
25. Display minimizes need for interpretation or memorization.	Yes	Virtually no memorization is required.
26. Activation of menu options is easy.	Yes	
27. Display formats are consistent across system.	Yes	
28. Wording is consistent across all displays.	Yes	
29. Text displays are easy to read.	No	Font size should be larger.
30. Display coding methods consistent across displays.	Yes	

TABLE 2. AFOTEC SYSTEM USABILITY GUIDELINES (Continued)

GUIDELINE	MET?	COMMENTS
31. Windows are easy to open and close.	No	Given prototyping environment, system crashes by accidentally closing windows.
32. It is easy to scroll with windows.	No	It is sometimes difficult to operate the altitude slider. It is also very slow.
33. Display symbols conform to operational conventions.	Yes	
34. Graphic symbology is appropriate for the info it represents.	Yes	
35. Icons used consistently across different displays.	Yes	
36. The use of color enhances display readability.	No	Need better contrast between wind barbs/wind contours and lightning/radar.
37. System messages are informative and concise.	No	System messages do not exist.
38. User's manual provides complete descriptions of procedures.	No	See section 5.1.1.2.
39. User's manual easy to use.	No	See section 5.1.1.2.
40. Display colors are consistent with operational conventions.	Yes	No standard colors exist for Flight Category, AIRMETs, Icing, or Turbulence.

TABLE 2. AFOTEC SYSTEM USABILITY GUIDELINES (Continued)

GUIDELINE	MET?	COMMENTS
41. System functions are organized in a manner that is consistent with job tasks.	No	See section 5.1.2.2.2.
42. Routine operations can be performed w/out user's manual.	Yes	
43. System allows operator functions to be performed optimally.	No	See section 5.1.2.2.2.
44. Functions that the user has not performed for a period of time are easily relearned.	Yes	

e. Guideline 10: The modes on the display do not always disengage. For instance, when changing modes, both the old and new mode buttons remain depressed. When this happens, the user must click on the new mode button a second time to disengage the previous mode. All mode buttons should easily disengage when a second mode button is pressed.

f. Guideline 12: System defaults should be set to the most frequently used products; however, the AWRP currently defaults to the Icing Product. If both AFSS and TMU users are considered, the Radar Mosaic and Airmen's Meteorological Information (AIRMET)/Significant Meteorological Information (SIGMET) products are probably most often used. The system should default to one of these products or allow user definition of defaults.

g. Guideline 13: As indicated earlier (item c), the AWRP display has a busy indicator; however, it does not accurately reflect the system state.

h. Guideline 14: Menu items are not organized by function or order. The mouse mode and product buttons should be organized according to use. For instance, the zoom button should be first in the row of mode buttons. The zoom mode is used most often; yet, it is located in the middle of the buttons. It can be difficult to locate in time critical situations. Users have indicated that convective products are most important and most often needed; yet, the radar button is not first in the product list. Additionally, overlays in the Weather Overlay menu are not organized according to function. For instance, when obtaining radar overlays, convective related overlays (e.g., Lightning, Area Motions, and Convective SIGMETS) are scattered throughout the list. Overlays should be grouped by product or function.

i. Guideline 24: In some instances, display updates do not keep pace with user inputs. When retrieving text, the system requires several seconds to display the text. Additionally, when changing flight levels, the display requires several seconds to update.

j. Guideline 29: Font size should be larger. The display may be difficult to read at distances greater than 2 feet.

k. Guideline 31: Windows are difficult to close. While all windows have exit buttons, they also have the "close dot" in the upper left hand corner. Most users are familiar with the Personal Computer (PC) windows environment where pressing the dot closes the window. However, in a Unix environment, pressing the dot exits the window and causes the system to crash.

l. Guideline 32: The altitude slider bar can be difficult to use. Not only is the update rate very slow, but the slider bar can be difficult to manipulate. Many times when releasing the "thumb" or slider button at a new altitude, the "thumb" or slider button has continued to move higher or lower. Given the slow update rate, the user must wait for the altitude to adjust and then move the thumb to the correct altitude.

m. Guideline 36: Color coding does not enhance display readability in two instances. Better contrast needs to be provided between the wind barbs and wind contours at 70 and 130 knots (kts)(see figure 2). Lightning strikes are also difficult to detect against level 3 and 4 precipitation (see figure 3). Colors need to be changed to provide better contrast.

n. Guideline 37: The AWRP display does not have system messages. Informative and concise system messages regarding errors or incorrect data entry should be added.

5.1.1.1.3 Military Standard 1472D.

Table 3 presents the results of the comparison of the AWRP interface characteristics to Military Standard 1472D (MIL-STD 1472D) standards. Design guidelines stated in table 3 not met by the AWRP are as follows:

a. Guideline 1: Auditory or visual warnings and/or alerts are not provided on the AWRP display. Warnings should be implemented for critical changes in data and data entry errors.

b. Guideline 2: Sufficient contrast is not provided between wind barbs and 70 or 130 kts wind contours (see figure 2); lightning strikes and levels 3 and 4 of the Radar Mosaic (see figure 3); and the Icing AIRMET and Mountain Obscuration AIRMET (see figure 4). Colors should be changed to provide appropriate contrast.

c. Guideline 12: In some instances, the display is not refreshed in a synchronous manner. Radar Mosaic provides seamless updates; however, Aviation Gridded Forecast System (AGFS) products require 2 to 3 seconds to refresh. During these 3 seconds, the screen goes blank, leaving the controller with no data to refer to. Refresh rates need to be faster for AGFS products.

d. Guideline 14: The font style is appropriate; however, the font size should be larger to make character discrimination easier.

5.1.1.2 User's Guide.

The AWRP User's Guide was evaluated for accuracy regarding system performance and its effectiveness in describing product use. More specifically, the User's Guide was reviewed for an accurate explanation of interface devices, product and function operation, and error messages. Paragraphs 5.1.1.2.1 and 5.1.1.2.2 contain comments regarding the User's Guide.

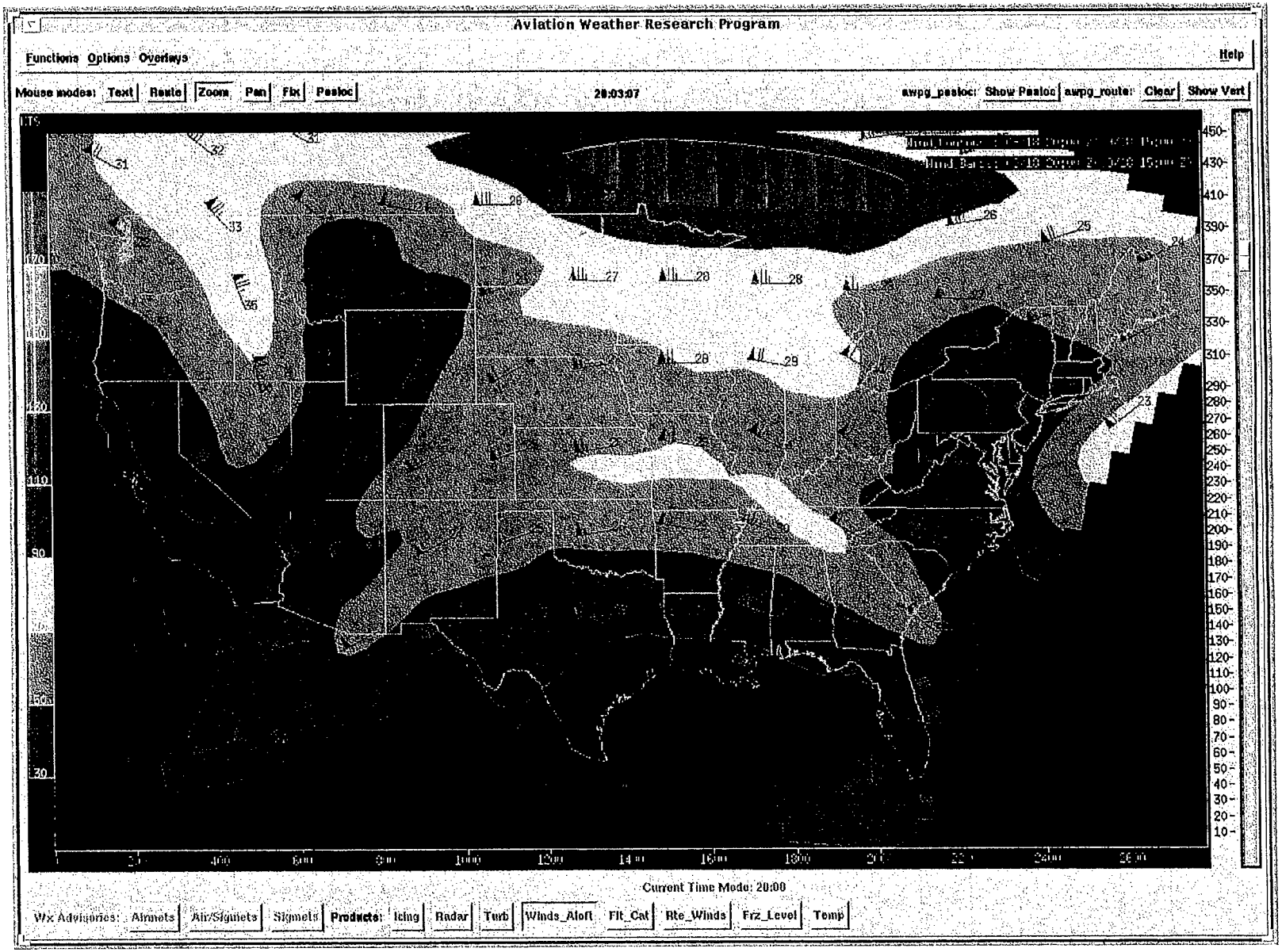


FIGURE 2. WINDS ALOFT COLOR CONTRAST

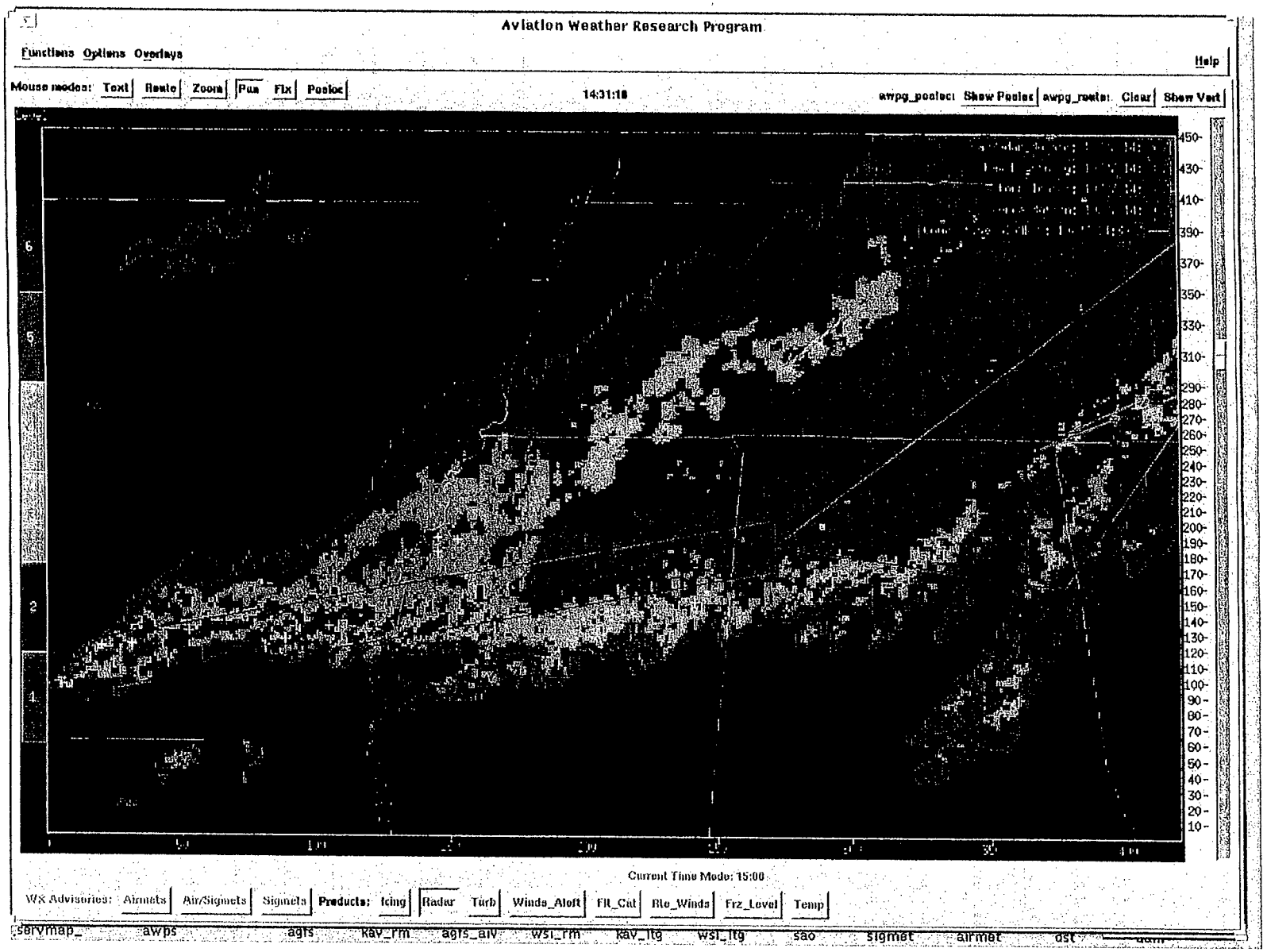


FIGURE 3. LIGHTNING STRIKE COLOR CONTRAST

TABLE 3. MIL-STD-1472D STANDARDS

STANDARD	MET?	COMMENTS
1. Alert/warning display shall provide increased probability of detecting condition.	No	Warnings or alerts are not provided.
2. Sufficient contrast shall be provided between display info and display background.	No	Green wind barbs do not contrast with 70 or 130 kts contours. Lightning does not contrast with VIP levels. Icing and Mtn. Obscuration AIRMETs are hard to differentiate.
3. Information shall be sufficient to allow the user to perform intended mission.	No	See section 5.1.2.
4. Redundancy in the display shall be avoided unless required to achieve reliability.	Yes	
5. Company names not related to function shall not be on the panel.	Yes	
6. Displayed information shall have duration of sufficient length to be reliably detected.	Yes	User-paced product by product. User controls information rate.
7. Numerics not used when perception of pattern variations is important.	Yes	Wind barbs show overall wind direction.
8. Red is used to alert.	Yes	Level 6 precip., LIFR.
9. Green denotes satisfactory conditions.	Yes	

TABLE 3. MIL-STD-1472D STANDARDS (Continued)

STANDARD	MET?	COMMENTS
10. White implies no decision.	Yes	
11. Yellow advises caution or marginal conditions.	Yes	
12. Displays requiring refreshed information shall update in a synchronous manner.	No	Radar provides seamless updating; AGFS products require 2-3 second refresh rate.
13. Avoid use of flashing lights.	Yes	
14. Font style should allow discrimination of similar characters such as l from 1.	No	Font style is appropriate. Font size should be larger.

FIGURE 4. ICING AND MOUNTAIN OBSCURATION AIRMET COLOR CONTRAST

5.1.1.2.1 General Comments.

Overall, the User's Guide provided a good description of AWR products. However, instructions regarding manipulation of the user interface in section 3. of the User's Guide tended to be inconsistent, unclear, and inaccurate at times. Paragraph 5.1.1.2.2 will address specific comments regarding the entire document.

5.1.1.2.2 Specific Comments.

All references (e.g., page 2, section 1.2) in this paragraph refer to the AWRP User's Guide.

a. Page 2, section 1.4, Description - Font differentiation to indicate features that are not currently available: Helvetica font does not provide adequate differentiation from standard font. Features not available should be shadowed or highlighted to ensure easy discrimination.

b. Page 6, section 3.1, Introduction: It is not necessary to differentiate the Graphical User Interface (GUI) from the AWRP display. The user considers the mouse, not the GUI, as the primary means of interacting with the AWRP display. Therefore, the GUI tutorial (i.e., "A GUI provides the mechanism through which the user accesses the functionality...") is not necessary in the User's Guide. Explaining the difference between the GUI and the display may cause confusion among users.

c. Page 7, figure 2, On versus Off State: Figure 2 provides a good visual example of a button in an "On" versus "Off" state.

d. Page 8, figure 3, A Slider: The arrows do not clearly indicate which features of the slider are labeled. While the "trough" is labeled on the diagram, it is never mentioned in the text. When discussing the "second method of manipulation," use of the slider bar is mentioned; however, the slider bar is not labeled on the diagram.

e. Page 9, figure 4, Text Input Windows: The text in section 3.2.4 refers to the "hollow box"; however, the "hollow box" is not labeled in the diagram.

f. Page 9, section 3.3.1, Plan View Window: Two-Dimensional and 3-Dimensional products are discussed. It is necessary to clarify which three dimensions are being considered since the AWRP has 4-Dimensional products.

g. Page 9, section 3.3.1, Plan View Window: The user is instructed to see the "Flight Level" section for further directions. No section number is indicated to direct the user to the appropriate section. Furthermore, the user is told that the "Flight Level" section is below section 3.3.1; however, this section does not follow section 3.3.1. If the user refers to the Table of Contents to locate the "Flight Level" section, the section is listed as being on page 25; yet, it actually appears on page 26.

h. Page 9, section 3.3.2, Vertical Cross Section Window: The user is referred to a different section (e.g., see "Flight Path" section) for a complete explanation of the Vertical Cross Section. This section should contain all information regarding the Vertical Cross Section. The user should only be required to refer to information previously discussed in the document and not information discussed several pages ahead.

i. Page 9, section 3.3.2, Vertical Cross Section Window: The section does not tell the user the function of the Vertical Cross Section Window.

j. Page 9, section 3.4, Description of the AWRP Display GUI: Since the user does not differentiate the GUI from the display, the GUI and the display should be considered as one entity in this document. Refer to the display and GUI simply as the AWRP Display.

k. Page 9, section 3.4.2, Weather Product Select Buttons: The first part of the section states that only one product can be viewed at a time. However, the last sentence in the section states that "If you wish to view more than one weather product at a time, see the section below on Weather Overlays." The Weather Overlays section is not located below the section in which it is referenced and does not appear in the User's Guide until page 24.

It also has been assigned an incorrect page number in the Table of Contents.

l. Page 10, section 3.4.2, Modes: A mouse click should be defined as the depression and release of the mouse button. Many uses of the mouse on the AWRP require more action than a simple mouse click. In some instances, the user is required to click and drag to create lines or boxes (e.g., zoom and pan). Caution should be used referring to "mouse clicks" in the general sense.

m. Page 11, section 3.4.2.1, Text Mode: The text mode is only valid for some products. These products should be listed (e.g., AIRMETs, SIGMETs, and Surface Aviation Observations [SAOs]).

n. Page 12, section 3.4.2.1, Text Mode: The last part of the section provides a good explanation of how to obtain text for an AIRMET or SIGMET.

o. Page 12, section 3.4.2.2, Flight Route Select Mode: "Flight Route" and "Flight Path" are used interchangeably in the document. Convert all references to "Flight Route." The "Clear Route" and "Show Vertical" buttons are discussed in the section; however, no reference is made regarding the location of these buttons on the display.

p. Page 13, section 3.4.2.3, Zoom Mode: Toward the end of the section, the user is told that using the middle mouse button zooms in a specified percentage. The percentage needs to be defined and it needs to be indicated whether or not the user can control this percentage. Additionally, the user is told to use the "Function Menu" to zoom out to view the entire continental United States. No mention is made regarding the location of the menu on the display.

q. Page 13, section 3.4.2.4, Pan Mode: Caution should be exercised when assuming the user is thinking incorrectly (e.g., "It is incorrect to think of this feature as ...). This type of wording may have a negative impact on the user.

r. Page 16, section 3.4.2.6, Positional Locator Mode: Exiting out of the Positional Locator is not explained in the text. Earlier in the document (see section 3.4.2), the user was told to choose a new mode to exit an old mode. This does not

work in the Positional Locator mode. To exit from the Positional Locator window, the user must activate a different mode and then click on the exit button in the Positional Locator window to close the window. However, this exit button is "grayed out" when the Positional Locator Mode is active (see figure 5). This leaves the user with no way to close the Positional Locator window while in the Positional Locator Mode. This is not consistent with the text mode where the user can close the text window via the exit button while still in the text mode.

s. Page 18, section 3.4.2.6, Positional Locator Mode: When using symbology not considered standard knowledge for the user (e.g., Iron Cross), provide a depiction of the symbol.

t. Page 18, section 3.4.2.6, Positional Locator Mode: When requiring a user to input data in a specific format, provide an example that the user can reference. Always specify whether the items should be separated by forward slash or backslash. Also, be consistent in discussing the data entry format. In one instance, the user is told that the bearing should be entered before the range; however, two paragraphs later, the user is told that all positions will be returned in the range/bearing format.

u. Page 35, section 4.3.1, Icing Potential: Valid time and run time are referred to in the text. Some users may not be familiar with model data; therefore, valid time and run time should be defined.

v. Page 44, section 4.3.5, table 1, Flight Category Definitions: Users do not need to know Boolean Logic to understand the table; therefore, the operators column labeled "boolean" should be relabeled.

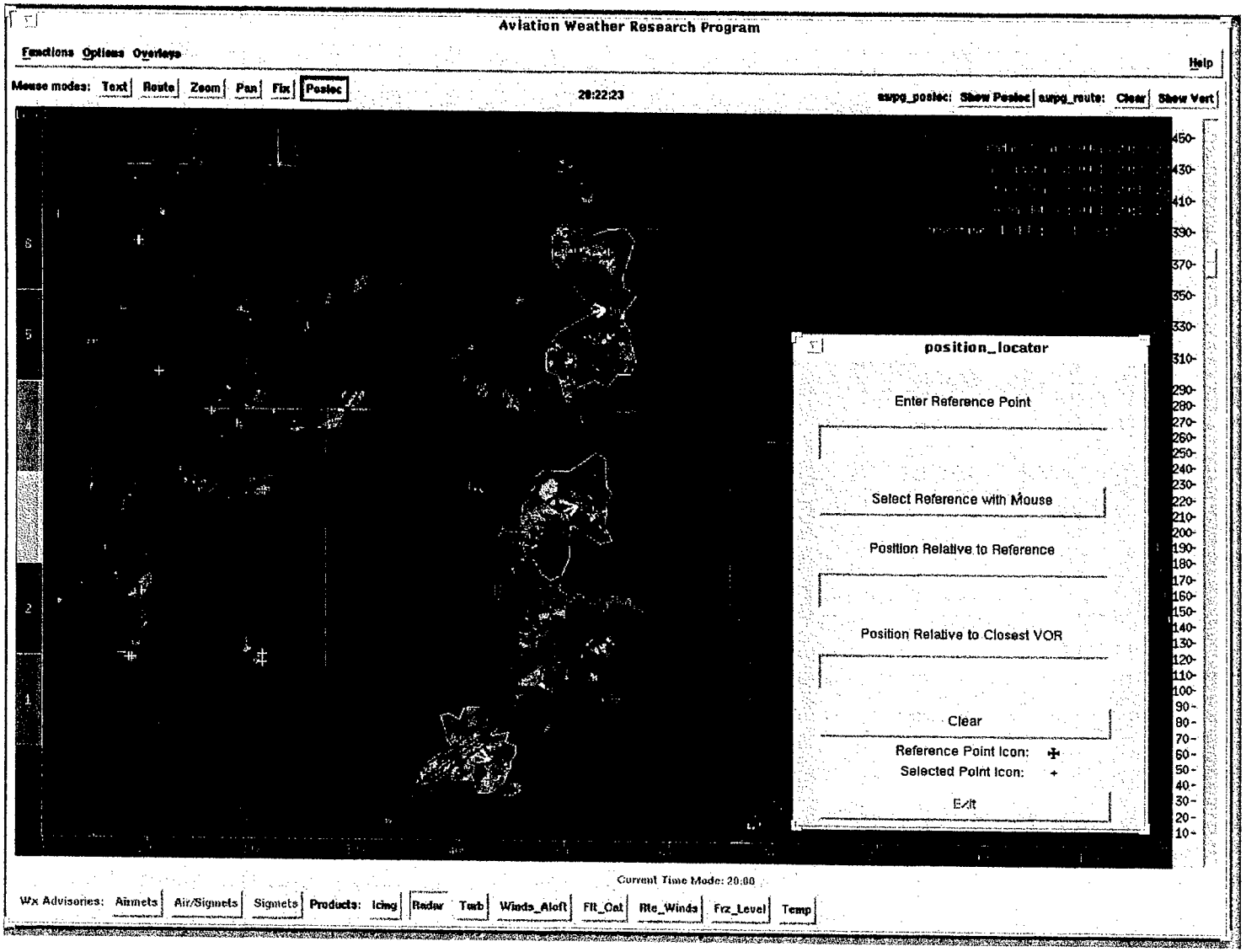


FIGURE 5. POSITIONAL LOCATOR WINDOW

5.1.2 Operational Analysis Stage.

This section will present the results from the operational analysis portion of the evaluation. It will discuss the comparison of the AWRP display against user requests from the ATUWG and the 1993 Demval. This section will also address how well the AWR products could be expected to fulfill user needs in an operational setting. This was accomplished by comparing products and functions to controller job tasks and weather information needs.

5.1.2.1 ATUWG and 1993 Demval Requests.

Requests from the ATUWG and the 1993 Demval were compared to the AWR products, functions, and interface characteristics. Results are presented in tables 4, 5, and 6. User's requests were based on operational needs. While some requests may be beyond the scope of the AWRP, these products and features should be viewed as required to successfully provide all necessary information to specialists/controllers in an operational setting. These requests are outlined in the subsequent paragraphs.

5.1.2.1.1 ATUWG General User Requests.

Table 4 presents the results for the ATUWG general user requests. User Requests stated in table 4 not met by the AWRP are as follows:

a. User Request 1: A busy indicator was implemented; however, it does not appear immediately following user input. It can take up to several seconds to appear. The busy indicator should appear immediately following input.

b. User Request 2: A clear button to return the system to default settings has not been implemented.

c. User Request 4: Users requested Pilot Reports (PIREPs) be displayed on the AWRP; however, PIREPs are not displayed. PIREP information in the area of icing and turbulence are very important to controllers. PIREPs should be available as an overlay product.

TABLE 4. AIR TRAFFIC USER WORKING GROUP MEETING REQUIREMENTS

USER REQUEST	MET?	COMMENTS
1. Implement busy icon to indicate when the system is processing.	No	Indicator exists, but it does not reflect system status.
2. Provide clear button to return to default settings.	No	Has Clear route button. No overall clear button.
3. Indicate growth, decay, and intensity for precipitation.	Yes	Indicates storm trend, area, and cell motion.
4. Provide PIREP information.	No	
5. Provide Instrument Flight Rule (IFR) and Mountain Obscuration AIRMETs.	Yes	
6. Provide forecast Flight Category product.	No	Currently, only SAO data is provided.
7. Make lat/long readouts active only in the FIX mode.	Yes	The product is very slow.
8. Display AGFS time with issue and current time.	Yes	
9. Contour winds 30 kts or greater/display winds in DDSSS(D-Direction, S-Speed).	Yes	30 kt winds contoured. Wind barbs still exist. Barbs should remain.
10. Add dynamic overlays for downed radars.	Yes	User's manual says feature exists, but it has not been observed since system started.
11. Overlays for jet airways.	No	Only five jet airways exist in overlay.

TABLE 4. AIR TRAFFIC USER WORKING GROUP MEETING REQUIREMENTS
(Continued)

USER REQUEST	MET?	COMMENTS
12. Add sustained wind AIRMET.	No	Not available.
13. Alarm for SAO updates	No	
14. Ability to scroll SAO text window.	Yes	Can also clear text window.

TABLE 5. AIR TRAFFIC USER WORKING GROUP COLOR REQUIREMENTS

USER REQUEST	MET?	COMMENTS
1. Background - Black	Yes	
2. Flight Route - Orange	No	It is white. Does not contrast well with Icing and Mtn. Obscuration AIRMETs.
3. Icing - Lt. Blue	No	It is white. Does not contrast well with mtn. obscuration AIRMETs.
4. Winds - White	No	Barbs are green. They do not contrast with 70 and 130 kt contours. White would provide good contrast.
5. Terrain - Brown	Yes	
6. Terrain 1500' Rule - Tan	No	Current color is Gray. While gray provides good contrast, users should be polled.
7. Temperature - Red	Yes	
8. Storm Movement - Teal	Yes	
9. Area Movement - White	Yes	
10. State Borders - Blue	Yes	
11. LIFR - Orange	No	It is red. Should be orange.
12. IFR - Red	No	It is yellow. Should be red, IFR is no-go for AFSS.
13. Marginal Visual Flight Rules (MVFR) - Lt. Blue	No	Blue is okay for TMU.

TABLE 5. AIR TRAFFIC USER WORKING GROUP COLOR REQUIREMENTS
(Continued)

USER REQUEST	MET?	COMMENTS
14. Visual Flight Rules (VFR) - Green	Yes	
15. Turbulence - Yellow	Yes	
16. Lightning- White(1min)/Gray(4min)	No	Yellow is 5 minutes old. White is 1 minute old. Neither contrast well against Level 3 and 4 precipitation.
17. Convective SIGMETs - Fuscia	Yes	
18. Mtn. Obscuration - White	No	Gray currently. Does not provide contrast with current icing color.
19. AIRMETs - solid lines	Yes	
20. SIGMETs - dashed lines	No	Convective and Miscellaneous SIGMETs are solid lines.
21. VORs - White	Yes	
22. Airports - Yellow	Yes	
23. Center/Sector Boundaries - Green	Yes	

TABLE 6. 1993 DEMVAL REQUIREMENTS

USER REQUEST	MET?	COMMENTS
1. Display wind in numeric format since barbs are difficult to read.	No	Note: Should not change. Human Factors standards suggest barbs since they indicate wind direction.
2. Incorporate lightning playback or history loop.	No	
3. Be able to display cross section using pre-selected range of altitude.	No	Still provides full range of altitude.
4. Incorporate 12 and 24 hour forecasts.	No	Still hourly and 6 hr.
5. Add all public use airports to airport overlay.	No	
6. Incorporate use of function keys.	No	
7. Add satellite imagery, looping, and PIREPs.	No	
8. Incorporate a continuous location readout.	No	
9. Add storm area movement to the Radar Mosaic.	Yes	
10. Increase range of wind contours down to 30 kts.	Yes	
11. Incorporate approach control boundaries to low sector overlay.	No	
12. Add capability to overlay SIGMETs on the Radar Mosaic.	Yes	

d. User Request 6: In addition to plotting SAO reports, users have expressed a desire to have Terminal Forecast (FT) reports plotted as well. In essence, this would provide a forecasted Flight Category product. This has not been implemented on the AWRP display.

e. User Request 11: The current AWRP jet overlay database only contains five jet airways. All jet airways should be available to the user. This database should be updated.

f. User Request 12: Users requested sustained wind AIRMETs; however, these AIRMETs have not been implemented on the display.

g. User Request 13: While SAO reports are displayed, users requested an audible indication when SAO reports were updated. No such indication exists on the current AWRP display.

5.1.2.1.2 ATUWG Color-Coding Requests.

Table 5 presents the comparison results from the ATUWG product/display color-coding requirements. User requests stated in table 5 not met by the AWRP are as follows:

a. User Request 2: Users requested an orange flight route. It is currently white. This may only present a problem if the user is drawing a route in the Icing Product with AIRMETs overlaid. In this case, the route may not be distinguishable against the Icing AIRMET.

b. User Request 3: Users requested light blue Icing AIRMETs; however, the current Icing AIRMET is outlined in white. While a light blue outline of the AIRMET may not contrast with a light blue gridded icing field, the current white AIRMET does not contrast with the gray mountain obscuration AIRMET. Better contrast needs to be provided.

c. User Request 4: White wind barbs were requested by users. Wind barbs on the current AWRP display are light green. The light green wind barbs are difficult to distinguish in the 70- and 130-kt wind contours as these contours are lighter shades of green. White wind barbs would provide better contrast and easy discrimination against all wind contour colors.

d. User Requests 11-14: The current Flight Category color scheme is as follows:

1. Low Instrument Flight Rule (LIFR) - red,
2. IFR - yellow,
3. MVFR - blue, and
4. VFR - green.

AFSS and ARTCC users had requested the following:

1. LIFR - orange,
2. IFR - red,
3. MVFR - light blue, and
4. VFR - green.

NOTE: Since AFSS users and ARTCC users experience hazardous conditions under different categories, color-coding should be different for each of these user groups. For AFSS users, critical decisions occur during IFR conditions; therefore, the color scheme for AFSS users should be:

1. LIFR - orange,
2. IFR - red,
3. MVFR - yellow, and
4. VFR - green.

Since critical decisions for ARTCC users begin during LIFR conditions, the current color scheme is appropriate.

e. User Request 16: Currently, 1-minute-old lightning is white and 2 to 5-minute-old lightning is yellow. Neither the white nor yellow strikes contrast well with the reflectivity levels on the Radar Mosaic. Lightning strikes should be easy to differentiate when overlaid on the Radar Mosaic.

f. User Request 18: The current gray Mountain Obscuration AIRMETs are difficult to differentiate from the white Icing AIRMETs. Better contrast should be provided.

g. User Request 20: SIGMETs should be drawn using broken or dashed lines. Convective SIGMETs and miscellaneous SIGMETs are drawn using solid lines. These lines should be dashed to remain consistent with all other SIGMETs (i.e., icing and turbulence).

5.1.2.1.3 1993 Demval Requests.

Table 6 presents the comparison results for user requests made during the 1993 Demval. The AWRP display did not meet all user requests as outlined in table 6. Results were as follows:

a. User Request 1: Users had requested Winds Aloft be displayed in an all numeric presentation (e.g., DDDSS).

NOTE: The current staff and barb depiction allows for easy pattern perception of overall wind flow patterns. The current depiction should remain as it follows human factors design principles.

b. User Request 2: A lightning playback or looping feature was requested. This feature has not been implemented. The need for a looping feature was discussed in section 5.1.1.1.1, item d.

c. User Request 3: Users indicated they wanted to only see the cross section window for a preselected range of altitudes (i.e., 4000-10000 feet). Currently, the cross section displays all vertical levels. AFSS Specialists indicated that their primary concern is weather 2 to 3 flight levels above and below the route of flight.

d. User Request 4: Twelve and 24-hour forecasts were requested. AWRP currently provides hourly forecasts out to 6 hours. Twelve and 24-hour forecasts are often used by specialists for pilot weather briefings and outlook briefings.

e. User Request 5: AFSS Specialists would require public use airports on the AWRP overlay. These airports are not currently on the overlays. Additionally, the current Victor Airway database is incomplete. All overlay databases need to be completed and updated.

f. User Request 7: AFSS Specialists utilize satellite imagery on a daily basis and have requested it as a product on the AWRP display. Satellite imagery should be incorporated into the display.

g. User Request 11: Users requested the addition of approach control boundaries to the low sector overlay. They have stated this overlay would be useful in determining if weather was impacting the terminal airspace.

5.1.2.2 JTA Comparison.

Products and features on the AWRP were compared to the weather information requirements of Inflight Specialists, Preflight Specialists, Enroute Flight Advisory Specialists (EFAS), and ARTCC TMCs as defined in ACT-320's JTA report. The comparison considered what information was needed and how that information was presented.

5.1.2.2.1 Information Requirements.

While this evaluation considers products for their individual merits, the collection of AWR products was also assessed for its completeness in providing users with all required weather information. This section will examine the extent to which the AWRP meets the information needs for the positions listed in paragraph 5.1.2.2. Information requirements, as determined in the JTA, were compared to information provided by products and functions on the AWRP display. Requirements are listed by position, but are not linked to specific job tasks associated with that position. For a complete analysis of information requirements for each position's job tasks, see the JTA diagrams and tables listed in appendix A.

5.1.2.2.1.1 AFSS Preflight Specialists.

The primary weather-related job task of a preflight specialist is to provide preflight weather briefings to General Aviation (GA) pilots. In order to accomplish this task, the specialist is required to have knowledge of and provide several types of weather information to pilots. Table 7 lists a preflight specialist's weather information needs as defined by the JTA and indicates whether they were satisfied by the AWR products. As

noted in table 7, the AWRP provides preflight specialists with 7 complete products and 2 partial products out of 15 total products needed to complete their weather-related job tasks. Additionally, in providing an Outlook Briefing (based on weather conditions expected beyond 6 hours) specialists would not be able to retrieve the necessary information from the AWRP. The comparison results suggest that if the AWRP was currently being used by preflight specialists in an operational setting, the display would have to be supplemented with additional weather systems (e.g., Model 1 Full Capacity [M1FC] or vendor weather systems).

5.1.2.2.1.2 AFSS Inflight Specialists.

The primary weather-related job tasks of an inflight specialist are to provide weather briefings, issue broadcasts, and issue local airport advisories to GA pilots. In order to accomplish these tasks, the specialist is required to have knowledge of and provide several types of weather information. Table 8 lists an inflight specialist's weather information needs as defined by the JTA and indicates whether they were satisfied by the AWR products.

As shown in table 8, the AWRP provides inflight specialists with 8 complete products and 2 partial products out of 18 total products needed to complete their weather-related job tasks. Similar to the preflight specialist, inflight specialists issue Outlook Briefings requiring forecasts beyond 6 hours. Again, results suggested that supplemental weather systems would be necessary in an operational setting.

TABLE 7. PREFLIGHT SPECIALIST'S WEATHER INFORMATION REQUIREMENTS

WEATHER REQUIREMENT	**AVAILABLE ON AWRP?**
Radar Mosaic	Yes
LLWAS	No
Convective Activity (including lightning)	Yes
Icing	Yes
Turbulence	Yes
Weather Advisories (AIRMETs, SIGMETs, Center Weather Advisories [CWAs], Severe Weather Watch)	AIRMETs, SIGMETS - Yes CWAs, Severe Weather Watch - No
Synopsis (frontal activity, pressure areas)	No
Terminal Forecasts	No
Current Conditions (SAO, PIREPs)	SAOs - Yes PIREPs - No
Satellite Imagery	No
Area Forecast	No
Prognosis Charts (12-24hr)	No
Winds Aloft	Yes
Upper Air Moisture	No
Weather Depiction (VFR, IFR conditions)	Yes

TABLE 8. INFLIGHT SPECIALIST'S WEATHER INFORMATION REQUIREMENTS

WEATHER REQUIREMENT	**AVAILABLE ON AWRP?**
Radar Mosaic	Yes
LLWAS	No
Convective Activity (including lightning)	Yes
Icing	Yes
Turbulence	Yes
Weather Advisories (AIRMETs, SIGMETs, CWAs, Severe Weather Watch)	AIRMETs, SIGMETs - Yes CWAs, Severe Weather Watch - No
Synopsis (frontal activity, pressure areas)	No
Terminal Forecasts	No
Current Conditions (SAO, PIREPs)	SAOs - Yes PIREPs - No
Satellite Imagery	No
Area Forecast	No
Prognosis Charts (12-24hr)	No
Winds Aloft	Yes
Upper Air Moisture	No
Runway Visual Range (Airport dependent)	No
Airport Wind Direction and Speed	Yes, via the textual SAO reports
Wake Turbulence	No
Weather Depiction (VFR, IFR conditions)	Yes

5.1.2.2.1.3 AFSS EFAS Specialists.

The primary weather-related job tasks of an EFAS specialist are to disseminate enroute weather, interpret unforecasted weather trends, and solicit PIREPs. In order to accomplish these tasks, the specialist is required to have knowledge of and provide several types of weather information. Table 9 lists an EFAS specialist's weather information needs as defined by the JTA and indicates whether they were satisfied by the AWR products.

As noted in table 9, the AWRP provides EFAS specialists with 8 complete products and 2 partial products out of 18 total products needed to complete their weather-related job tasks. The AWRP would require supplemental weather systems to provide appropriate weather information for completing weather-related job tasks in an operational environment.

5.1.2.2.1.4 ARTCC Traffic Management Coordinators.

The primary job task of an ARTCC TMC is to provide a safe and efficient traffic flow into, out of, and within the ARTCC's airspace. While a TMC is not required to perform weather specific job tasks, weather is a crucial factor in managing an ARTCC's traffic flow. In providing this traffic management function, the TMC will often reroute and meter traffic to safely divert airplanes around hazardous weather. In order to accomplish this task, the TMC is required to have knowledge of several types of weather information. Table 10 lists a TMC's weather information needs as defined by the JTA and indicates whether they were satisfied by the AWR products.

As noted in table 10, the AWRP provides TMCs with 5 complete products and 3 partial products out of 13 total products needed to complete their job tasks. The AWRP would require supplemental weather systems to provide a TMC with the appropriate weather information to complete job tasks in an operational environment.

TABLE 9. EFAS SPECIALIST'S WEATHER INFORMATION REQUIREMENTS

WEATHER REQUIREMENT	**AVAILABLE ON AWRP?**
Radar Mosaic	Yes
LLWAS	No
Convective Activity (including lightning)	Yes
Icing	Yes
Turbulence	Yes
Weather Advisories (AIRMETs, SIGMETs, CWAs, Severe Weather Watch)	AIRMETs, SIGMETs - Yes CWAs, Severe Weather Watch - No
Synopsis (frontal activity, pressure areas)	No
Terminal Forecasts	No
Current Conditions (SAO, PIREPs)	SAOs - Yes PIREPs - No
Satellite Imagery	No
Area Forecast	No
Prognosis Charts (12-24hr)	No
Winds Aloft	Yes
Upper Air Moisture	No
Runway Visual Range (Airport dependent)	No
Airport Wind Direction and Speed	Yes
Wake Turbulence	No
Weather Depiction (VFR, IFR conditions)	Yes

TABLE 10. ARTCC TMC's WEATHER INFORMATION REQUIREMENTS

WEATHER REQUIREMENT	**AVAILABLE ON AWRP?**
Radar Mosaic	Yes
Convective Activity (including lightning)	Yes
Icing	Yes
Turbulence	Yes
Weather Advisories (AIRMETs, SIGMETs, CWAs, Severe Weather Watch)	AIRMETs, SIGMETs - Yes CWAs, Severe Weather Watch - No
Terminal Forecasts	No
Current Conditions (SAO, PIREPs)	SAOs - Yes PIREPs - No
Satellite Imagery	No
Winds Aloft	Yes
Jet Stream	Partially (barbs provide direction)
Volcanic Ash	No
Surface Wind	No
Mountain Wave	No

5.1.2.2.2 Information Presentation.

This section will examine the extent to which the AWRP overcomes the information presentation problems of current weather systems as outlined in the JTA. Information presentation problems can be classified as problems with data display, data entry, or data retrieval.

Several issues associated with the presentation of information were identified in the JTA. These issues were (all references in this paragraph refer to the Job Task Analysis report completed by ACT-320):

a. Accessing and comparing weather information from several systems to ensure weather accuracy (see paragraph 5.2.2.1, 5.2.3.2) is time consuming and may lead to increased task difficulty as well as increased levels of workload.

b. Attempting to relate graphical and textual weather information (see paragraph 5.2.2.1) may increase the amount of mental interpretation required to properly utilize products. Increased interpretation may lead to increased levels of task difficulty and workload.

c. The need to read, interpret, and mentally filter several pages of M1FC text (see paragraph 5.2.2.1) is time consuming and inefficient.

d. Locally produced graphics are an attempt at reducing the amount of textual information (see paragraph 5.2.1.1); however, the process of creating these graphics is time consuming and needs to be improved.

e. Command line interfaces (typing in requests) on some of the current weather systems are tedious and time consuming (see paragraph 5.2.3.1). Additionally, this interaction becomes time consuming and frustrating when typographical errors are made.

f. Current vendor graphic weather systems are based on a user interface that is not efficient and requires too many user inputs for each request and/or action (see paragraph 5.2.3.1).

g. Mentally placing PIREPs along a route of flight can be tedious and time consuming (paragraph 5.2.2.1).

Given the issues identified in the JTA, the AWRP may provide the following improvements:

a. Issue A: Until the AWRP provides all required weather information, users would still need to access other systems.

b. Issue B: Since the AWRP does not provide all necessary weather information, users would need to retrieve additional information from other sources. Most of this information would be presented in a textual format. Thus, the comparison of textual and graphical information would still be required.

c. Issue C: The AWRP begins to alleviate this problem as it presents more information graphically.

d. Issue D: The AWRP overcomes the manual plotting process as the AWRP system provides advisories in a graphical format. This feature is not unique to the AWRP, however, since software can be purchased or created that automatically plots this information.

e. Issue E: Since the AWRP's primary input device is a mouse, the system does overcome the problem of typing errors. However, in many instances (e.g., changing altitude and retrieving SAOs), the AWRP does not have an acceptable response speed.

f. Issue F: While the current menu structure on the AWRP represents an improvement as it is better organized and decreases user memory reliance, the AWRP menu structure still needs to be improved further.

g. Issue G: The AWRP does not offer any relief from the PIREP problem as PIREPs are not available.

While the AWRP was not developed to satisfy the JTA, the AWRP does not address two of the more important conclusions from the JTA. First, it was suggested that products and functions be tailored to meet the needs of user's job tasks. The AWRP was designed to meet the needs of both AFSS Specialists and ARTCC TMCs. Since the requirements of these positions are inherently different, products do not fulfill the needs of either group.

Secondly, it was suggested that products be integrated on either a single current or future platform. Currently, no operational platform is capable of receiving the AWRP. Additionally, given that the AWRP does not provide users with the necessary weather information requirements, the AWRP could not be implemented as a single weather platform.

5.2 METEOROLOGICAL RESULTS AND DISCUSSION.

5.2.1 Meteorological Interpretation.

In the following paragraphs, each product is discussed with regard to the amount of meteorological interpretation needed. The level of interpretation for each product was assigned a numerical rating from 1 to 10 with 1 being no interpretation needed and 10 being complete interpretation needed. Table 11 summarizes the numerical interpretation ratings of each product.

TABLE 11. METEOROLOGICAL INTERPRETATION OF AWRP

Product	Level of Interpretation
Radar Mosaic	2
Storm Attributes	9
Winds Aloft	2
Temperatures Aloft	6
AIRMETS and SIGMETS	8
Current Flight Category	7
In-Flight Icing Potential	8
Route Winds	2

5.2.1.1 Radar Mosaic and Storm Attributes.

The AWRP Radar Mosaic displays six contour levels of radar reflectivity. The higher reflectivity levels correspond to heavier precipitation. The storm attributes consist of individual Storm Cell Motion and Area Motion through the use of vectors pointing in the direction of movement. The storm attributes also include cloud-to-ground lightning strikes displayed and updated every minute. In addition, Convective SIGMETs issued by the Aviation Weather Center (AWC) can overlay the Radar Mosaic. The level of interpretation by air traffic personnel of the Radar Mosaic should be minimal because the display is very similar to current operational radar mosaics. However, the storm attributes present the following interpretation issues:

a. The user must decide which motion product to use. The Cell and Area Motions are automated products that are calculated every 5 minutes. A separate area motion is also given in the Convective SIGMET as determined by an AWC forecaster viewing successive radar images. Situations were observed with the AWRP where the area motion is in one direction, the cell motion is in another direction, and the motion given in the Convective SIGMET is in a third direction. The differences in area and cell motion are to be expected since the area motion is governed by the growth and decay of cells within an area, while the cells are separate entities that move within the overall area. It is not apparent to the user when Cell Motion should be used rather than Area Motion and vice versa. One way of addressing this issue would be for Cell Motion to be available only on the terminal scale (i.e., on the order of tens of kilometers (km)).

b. If both the Area Motion and the Convective SIGMET are to be displayed, then the motions in each should be in general agreement. While differences are to be expected since the Area Motion is updated every 5 minutes while Convective SIGMETs are issued once per hour, the presentation of two different area motions is confusing and potentially dangerous. An example is shown graphically in figure 6. The area motion for the storms in southeastern Wisconsin and northeastern Illinois is given in Convective SIGMET 25C as from 330° (i.e., from the northwest) at 25 kts. The AWRP Area Motion is given by the white arrow near

Milwaukee, Wisconsin (MKE). The arrow clearly points towards, not from, the northwest with a speed of movement (shown at the head of the arrow) of 20 kts. Thus, the AWRP Area Motion and the motion given in the Convective SIGMET are completely opposite. The example in figure 6 was not an isolated occurrence.

c. A third issue with the storm attributes concerns the changing outline of storm areas and area motion defined by the AWRP. With 5-minute updates, the area outlines and the motion vectors fluctuate considerably. As a result, significantly different information could be given to end users on requests only minutes apart. It was noted that storm area outlines often would split, merge, disappear, change shape drastically, or any combination of the above from one 5-minute update to the next. More consistency is needed in the products. Some fluctuation is to be expected and occurs naturally within storm systems, but for enroute storm tracking, the overall trend of the system is important. The Radar Mosaic does not require a high level of interpretation and is assigned a numerical rating of 2. However, too much and potentially conflicting motion information is presented in the storm attributes. Therefore, the storm attributes product is ranked separately from the mosaic. Since a high level of interpretation is needed to discern which motion information to use, a numerical rating of 9 is assigned.

5.2.1.2 Winds Aloft.

Winds Aloft displays gridded wind information by using a staff pointed in the direction the winds are coming from and barbs on the staff indicating the wind speed. To aid in identifying the specific direction the wind is coming from, the compass direction in tens of degrees is displayed at the base of the staff. Filled contours of wind speed give immediate identification of the region of strongest winds at a flight level. The AWRP Winds Aloft are similar to current operational products. Meteorological symbolism is standard for wind depiction. Little to no interpretation should be needed by air traffic personnel. Therefore, the Winds Aloft level of interpretation is assigned a numerical rating of 2.

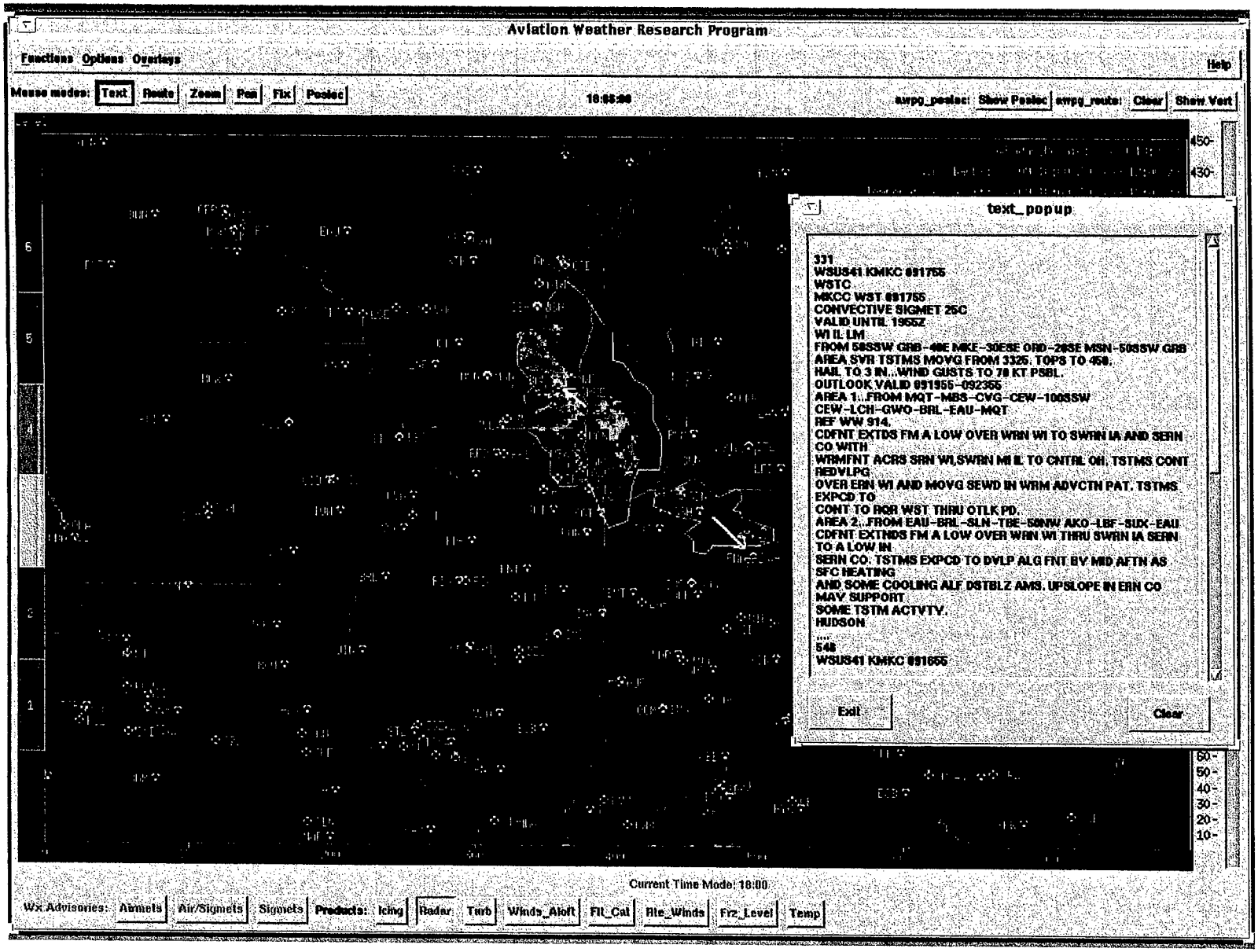


FIGURE 6. AWRP AREA MOTION AND CONVECTIVE SIGMET MOTION

5.2.1.3 Temperatures Aloft.

The Temperatures Aloft product displays temperature contours at 10° Celsius intervals with 5° intervals next to the 0° contour. At 10° Celsius intervals, the spacing between contours can be large and considerable interpolation between contours is needed in order to determine the temperature at a specific location. If the temperature is desired along a route of flight, the use of the vertical cross section yields a better picture that requires less interpolation. Since the information presented in the horizontal plan view is sparse, the Temperatures Aloft product level of interpretation is assigned a numerical rating of 6.

5.2.1.4 AIRMETs and SIGMETs.

AIRMETs and SIGMETs are graphically displayed on the AWRP horizontal plan view. Area boundaries are shown and are color coded in order to delineate different types of AIRMETs and SIGMETs. Updates are automatically incorporated by the AWRP and displayed as the AIRMETs and SIGMETs become available. The graphical display of AIRMETs and SIGMETs requires little interpretation as far as areal extent is concerned. However, other than the color coding to indicate the phenomena of interest, no other information is given. For example, the text for an Icing AIRMET must be retrieved and read to determine the location of icing (e.g., in cloud or in precipitation), the type, the severity, and the vertical extent of the Icing Potential. Standard meteorological symbology for icing types and the base and top of the area should have been incorporated into the display. Due to the lack of graphical information, the AIRMETs and SIGMETs level of interpretation is assigned a numerical rating of 8.

5.2.1.5 Current Flight Category.

The Current Flight Category Product displays a color filled circle at surface weather observation locations throughout the United States. Different colors correspond to the different flight categories of Visual Flight Rules (VFR), Marginal Visual Flight Rules (MVFR), Instrument Flight Rules (IFR), Low Instrument Flight Rules (LIFR). When an obstruction to visibility occurs at a location, the weather symbol for the

obstruction is plotted next to the location. AWRP weather symbols are standard meteorological symbols that air traffic personnel are required to know. The level of interpretation for individual airport locations is minimal. However, not enough information is given in the following two areas:

a. There is no information on areas between airports. The existence of conditions between airports is important from a general aviation standpoint. Since no information is given, considerable interpretation will be done for these areas. For example, accepted meteorological practices call for contouring of IFR and VFR areas based upon reports from airport locations and knowledge of terrain (e.g., valleys and ridges). Even though technically it cannot be stated that regions will be VFR between two known locations of VFR conditions, the tendency will be to form contours enclosing the two locations and the between regions. As a result, it is expected that considerable mental contouring (i.e., interpretation) of the AWRP display will take place.

b. There are no forecasted flight conditions. Thus, there is no information available for flight planning purposes. Users will be forced to obtain additional text information, such as terminal forecasts, to interpolate into the future.

Due to the presence of large regions without information and the lack of forecast information, the current flight category product requires a high level of interpretation and is assigned a numerical rating of 7.

5.2.1.6 Inflight Icing Potential.

The Inflight Icing Potential combines Icing AIRMETs with gridded areas of automated Icing Potential. The Icing AIRMETs are displayed at all flight levels, however, the automated Icing Potential is only displayed if icing potential is identified at the particular flight level of interest. As noted in paragraph 5.2.1.4, the graphical Icing AIRMET does not display any information on the type or severity of icing. The automated Icing Potential also does not display information on the type or severity. As stated in paragraph 5.2.1.4, meteorological symbolism could have been included with the graphical AIRMET to

identify the type and severity of icing. In addition, two interpretation issues were identified as follows:

a. Presentation of the Icing AIRMETs and the automated Icing Potential often results in conflicting information. The gridded icing areas do not always agree with the Icing AIRMETs. If both components are presented, they must be reconciled so that conflicting information is not displayed.

b. Additional interpretation is needed since only the icing potential at a particular flight level is shown in the horizontal view. It is not apparent to the user whether icing areas may exist directly above or below the selected flight level. This may be partially rectified by selecting a route of flight and viewing a vertical cross section. For example, figure 7 displays a route of flight in the horizontal view from eastern Maine across northern New York. The only area of icing potential is the gridded shaded area in northern New Hampshire. However, the vertical cross section displays another area of icing only about 1,000 feet below the selected flight level. The vertical cross section enables the identification of icing potential areas above and below the flight level. However, limitations still exist since icing potential areas may exist to either side of the route and these will not be displayed on the vertical cross section. In order to know fully what is occurring along and in the vicinity of the route of flight, it is necessary to scan through several flight levels, use a vertical cross section, and then mentally interpolate areas of icing identified in the scans to locations around the route. A mosaic of icing potential horizontally and vertically around the route of flight may provide a solution to this time consuming process. Since information on icing type and severity is not provided, together with conflicting information and the need to scan several layers in conjunction with a vertical cross section, the Inflight Icing Potential level of interpretation is assigned a numerical rating of 8.

5.2.1.7 Route Winds.

While stated as a separate product, the Route Winds are more suitable as an option of the Winds Aloft product. After a route of flight is identified, selecting the Route Winds option will display, in numeric format, the average winds along legs of the

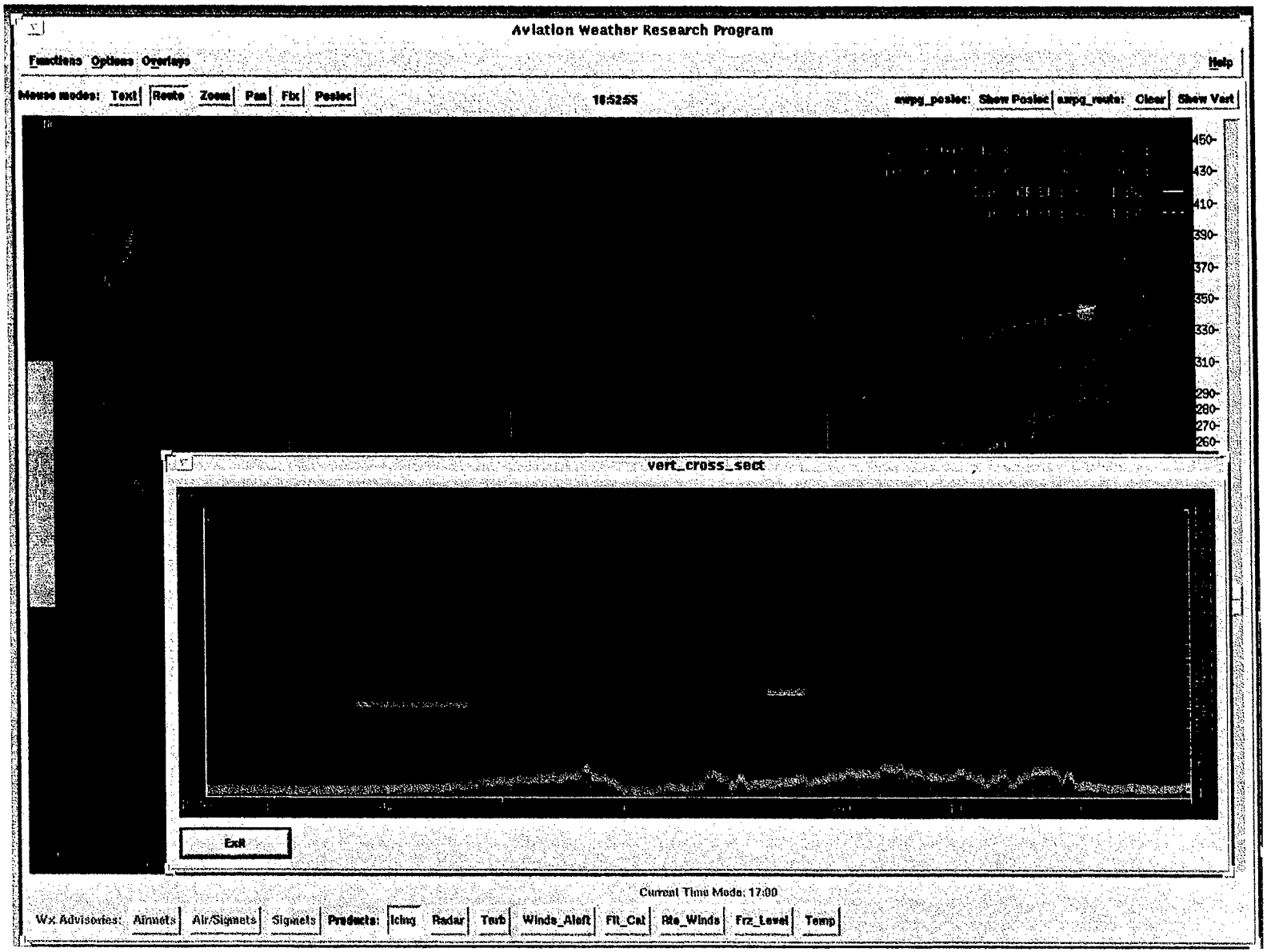


FIGURE 7. ICING POTENTIAL

flight. The only apparent interpretation issue is determining what exact distance each average wind applies to over the flight route. No meteorological symbolism is used. The Route Winds level of interpretation is assigned a numerical rating of 2.

5.2.2 Improvement Over Current Products.

In the following paragraphs, the AWRP is compared to current operational products viewed at the Millville, New Jersey, AFSS. While products may vary between AFSSs, the products viewed at Millville are considered representative of current operational capabilities. In each paragraph the AFSS products are summarized, followed by differences and improvements found in the AWRP.

5.2.2.1 Radar Mosaic and Storm Attributes.

The current operational AFSS radar product is a national radar mosaic that is updated every 5 minutes. Predefined regions can be selected in order to simulate a zoom capability. Looping of successive images is available in order to estimate movement, growth, and decay of precipitation areas. Individual radar sites may be selected for view; however, the selection process takes 3 to 6 minutes, which makes the capability virtually useless. The AWRP Radar Mosaic is similar to the current operational AFSS radar mosaic with the exceptions of no looping capability, and the inclusion of lightning information, storm attributes (i.e., storm motion) and the AWRP display features such as zoom and pan. The lightning information allows the identification of thunderstorm activity versus only the existence of precipitation. The automated AWRP storm motion information removes the user interpretation needed when using the current looping capability. However, in order for the motion information to be an improvement, the inconsistencies discussed in paragraph 5.2.1.1 must be corrected. One of the significant improvements of the AWRP Radar Mosaic is the inclusion of the zoom function and the corresponding rapid response time (on the order of 1 second) to zoom in on an area. It should be noted the zoom function is not unique to the AWRP. This function is available on many graphical weather systems currently provided by commercial vendors.

5.2.2.2 Winds Aloft.

Current operational AFSS Winds Aloft products display wind direction and speed represented by a staff with barbs attached. The products are limited to three vertical levels for analysis conditions and eight vertical levels for forecast conditions that are only valid at 12 hours from the twice daily analysis times. In AFSS operations, it is often faster to use textual wind information for specific locations rather than interpreting graphical data to locations of interest. The AWRP Winds Aloft offers improved spatial and temporal resolution. Vertical resolution is on the order of 1,000 to 2,000 feet with 25 levels available both for the analysis and forecast. Forecasts are available on an hourly basis with updates computed every 3 hours. Horizontal resolution is improved, thus decreasing the amount of interpretation that must be done in order to determine winds along a route that may fall in between grid points.

5.2.2.3 Temperatures Aloft.

As with the Winds Aloft, current operational AFSS Temperatures Aloft products are presented at three vertical levels for analysis and eight vertical levels for forecasts that are valid only at 12 hours from the twice daily analysis times. Spatial and temporal resolutions are the main deficiencies in current Temperatures Aloft products. The AWRP Temperatures Aloft overcomes the resolution deficiencies, but is limited by the level of interpretation needed as a result of the absence of display information over large regions of the country (see paragraph 5.2.1.3). Thus, resolution is improved over existing products, but the utility of the Temperatures Aloft product is questionable due to the high level of interpretation required.

5.2.2.4 AIRMETs and SIGMETs.

Current operational AFSS graphical AIRMETs and SIGMETs are created by manually plotting text information using a graphics pad. Along with the area outlines of each AIRMET or SIGMET is plotted text information identifying the particular phenomena and characteristics (e.g, severity, tops, and bases). Updates are manually created, thus there exists the possibility of missing an update or an initial release. The AWRP AIRMETs and SIGMETs are entirely automated thus removing the possibility of missing an

AIRMET or SIGMET. However, the AWRP display lacks any characteristic information. Characteristics about the AIRMET or SIGMET have to be found by the user scanning through text information. This effectively nullifies much of the improvement over current products.

5.2.2.5 Current Flight Category.

Currently, no AFSS flight category product exists. The closest operational product is the surface weather depiction which shows the position of high and low pressure systems, weather fronts, and current weather by using weather symbology, as well as contours of MVFR and IFR. The surface weather depiction is issued every 3 hours. For more recent updates, AFSS personnel must consult text information from locations of interest. The AWRP Current Flight Category gives automatic updates as reports become available on conditions at airport locations. No contouring is provided by the AWRP, although it is expected that mental contouring will occur over regions of concern.

5.2.2.6 Inflight Icing Potential.

No current capabilities exist other than the plotting of AIRMETs and SIGMETs discussed in paragraph 5.2.2.4. The AWRP presents a new capability. However, since Inflight Icing Potential gives no information on the type and severity of icing, improvements are predominantly with the automation of the Icing AIRMETs.

5.2.2.7 Route Winds.

Current operational capabilities for Route Winds consists of text information listing winds aloft at specific stations along a route of flight. These stations may or may not be evenly distributed along the route and may be several hours different from the time of flight. The AWRP Route Winds are displayed in the same numeric format as the current text information. Improvements over the current text product come from displaying the winds in a graphical manner that does not force the user to search through text material to find the relevant information. In addition, winds are averaged along evenly distributed portions of the route of flight and with hourly forecast data. As a result, the timing of the winds should more closely match the time of flight.

5.2.3 Meteorological Consistency.

The AWRP was evaluated for meteorological consistency between graphics and text. Also evaluated was consistency between individual products showing related phenomena over the same geographical region. Results of the meteorological consistency evaluation are outlined in table 12. Inconsistencies in the AWRP are discussed in the following paragraphs.

5.2.3.1 AIRMETs and SIGMETs.

a. In the absence of radar data, a user must rely on Convective SIGMETs to determine the location of thunderstorm activity. The incorrect plotting of a Convective SIGMET could have a significant negative impact upon aviation operations. Several occasions were identified with the AWRP when Convective SIGMETs were not plotted correctly. Incorrect plotting involved Convective SIGMETs defined with two or three points, along with a specified width, identifying a line of thunderstorms.

1. When only two points define a Convective SIGMET, the points identify the endpoints of the SIGMET. The SIGMET is extended equidistant to either side of the endpoints and perpendicular to a line connecting the two endpoints. Situations were identified with the AWRP where the endpoint extensions were not perpendicular to the line connecting the two endpoints. As a result, skewed Convective SIGMETs were displayed that did not cover the line of thunderstorms as was intended.

2. When a Convective SIGMET used three points to define a line of thunderstorms, the AWRP connected the three points in a triangle pattern enclosing an area. However, the intention of a three point Convective SIGMET defining a line of thunderstorms was to form a bow shaped line of the width specified in the SIGMET. As a result of the incorrect plotting by the AWRP, either the leading edge or the trailing edge of a line of thunderstorms was not covered by the Convective SIGMET.

b. According to the AWRP User's Guide, the capability exists to have text messages for particular AIRMETs or SIGMETs appear on the display. However, when the process for retrieving the text information is followed, the text for multiple AIRMETs and SIGMETs appears on the display and the user has to search for

TABLE 12. METEOROLOGICAL CONSISTENCY RESULTS

PRODUCT	RESULT
AIRMETS/SIGMETS	Graphic did not match text.
AIRMETS/SIGMETS	Text did not match particular AIRMET/SIGMET of interest.
AIRMETS/SIGMETS	Text was not current.
Radar Mosaic	Surface observations within reflectivity areas did not indicate precipitation.
Radar Mosaic	Convective SIGMET did not correspond to reflectivity.
Radar Mosaic	Area Motion did not agree with Convective SIGMET.
Winds Aloft	Vertical consistency was observed.
Temperatures	Vertical consistency was observed.
Temperatures	Agreed with icing potential temperature criteria.
Flight Category	Graphic did not match text.
Flight Category	Locations were not plotted correctly.
Flight Category	Idle locations were current.
Route Winds	Agreed with winds aloft.
Cross Section	Did not agree with plan view.

the one of interest. Since the AIRMETs and SIGMETs are not labelled on the graphical display, the user has to resort to geographical identifiers (usually state locations or location identifiers) to identify the desired text. Too much time is involved with identifying the AIRMET or SIGMET text of interest.

c. All displayed AIRMETs and SIGMETs had current text information with the exception of Convective SIGMETs. The AWRP display often had two overlying Convective SIGMETs in a single region. When the text for the SIGMETs was displayed, it was found that both SIGMETs had valid times, but one had been issued 1 hour before the other. Convective SIGMETs are valid for 2 hours; however, if after 1 hour they are still necessary, new ones are issued to replace those issued the previous hour. All Convective SIGMETs from the previous hour are superseded. The reason the Convective SIGMETs have a 2-hour valid period is strictly due to the possibility of communication failures or AWC being unable to issue Convective SIGMETs for a particular hour. In these cases, the Convective SIGMET from the previous hour would be valid for the full 2 hours or until a newer one is issued. The AWRP should not display Convective SIGMETs from a previous hour when current ones have been received.

5.2.3.2 Radar Mosaic.

a. Level one and two reflectivity levels from the AWRP Radar Mosaic had station observations within the reflectivity contours that did not report precipitation, but did report clouds aloft. Apparently, due to the distance from the radar, the precipitation was observed aloft by the radar and was evaporating before reaching the ground. Other isolated cases of anomalous propagation were observed where reflectivity was observed directly over a location, but the station observation did not contain any indication of precipitation or clouds aloft. While a small number of the above cases were observed, for the most part, the Radar Mosaic agreed quite well with the surface observations. It is likely the anomalies are in part due to the limitations of the radar rather than that of the AWRP.

b. The issue of Convective SIGMETs not agreeing with the radar reflectivity fields is addressed in paragraph 5.2.3.1.

c. The conflicts identified between the Radar Mosaic Area Motion and the area motion given in the Convective SIGMET are addressed in paragraph 5.2.1.1.

5.2.3.3 Current Flight Category.

a. Occasions were identified when the wrong color code was applied to individual stations. In one example, a station was color coded as VFR (i.e., ceiling greater than 3,000 feet), but the observation recorded a ceiling of 2,700 feet, which would place the station in the MVFR category. Another example of the graphics not matching the text was the display of the thunderstorm symbol for a station whose latest observation included only rainshowers. Thunderstorms had occurred the previous hour at the location but had finished by the time of the observation.

b. Problems with the location of stations were noted during the evaluation. Many stations located over water were erroneously assigned text messages for inland stations. It is not clear whether the problem was the wrong text given for an actual over water station or whether the station is incorrectly plotted. The inland stations that corresponded to the text were found in their correct geographical location. Recurring examples were PHL (Philadelphia, Pennsylvania), DOV (Dover, Delaware), and SBY (Salisbury, Maryland) which, while being in their correct geographical locations, were also plotted off the east coast in the Atlantic Ocean.

c. Stations depicted as being idle (i.e., no reports within the last 80 minutes) often had current observations available. Erroneously displaying the flight category as outdated could prompt a user to ignore the observation for a particular location.

5.2.3.4 Vertical Cross Section.

When displaying the Inflight Icing Potential product, it was noted on several occasions that the vertical cross section did not agree with the horizontal plan view. The discrepancies were not noted with any other products. Examples of discrepancies included a route selected through a gridded icing area which on the vertical cross section either showed the route under or over

(but not touching) the icing potential area. This would indicate that either the icing potential area was missing from the vertical cross section or the icing potential area did not extend as far as the horizontal plan view indicated. In the latter example, a route was chosen that began and ended within a continuous icing potential area. The corresponding vertical cross section showed the beginning and ending of the route outside of icing areas.

5.3 SYSTEM ADMINISTRATOR RESULTS AND DISCUSSION.

The AWRP Installation Documentation and AWRP System Management Documentation were evaluated to ensure accuracy and ease of understanding of procedures and information.

5.3.1 General Comments.

Sections of the documentation contained incorrect, inconsistent, and/or missing pieces of information. Paragraph 5.3.2 will address specific comments regarding each of the documents.

5.3.2 Specific Comments.

5.3.2.1 AWRP Installation - Executable Only Document.

a. Page 2, section 2.5: The documentation says that the live data AWRP system requires additional software to retrieve live data, but it does not say what software is needed. Clarify if this software is commercial-off-the-shelf(COTS)equipment or it has been developed in-house to suit individual sites.

b. Page 4, section 3.0: Step 8 consists of a list of directories that need to be created. When executing, the software errors are received indicating that a /home/awpg/live/data/ltg/wsi directory was also needed. Add this to the directory list.

5.3.2.2 AWRP Installation - Source Code Document.

a. Page 3, section 3.0: In step 3, the login name identified for the ftp is incorrect.

b. Page 5, section 3.0: kav_rm_demo.sh and wsi_ltg_demo.sh are found in directories other than ~/startup/demo. A line needs to be added informing the operator to change directories before editing these files.

c. Page 7, section 4.0: Step 1 indicates that <user-path>/awpg_user/bin should be added to the path. That directory structure does not exist using the awpg system. It seems likely that awpg_user should be replaced by awpg_version.

d. Page 9, section 7.1: The document states that some executables are not accompanied by their source code as part of the AWRP distribution. If it is because this information is proprietary, that should be stated.

5.3.2.3 AWRP Live System Management.

a. Page 8, section 4.3: If the software requires that "tmp" subdirectories exist under the data directories then that should be specified. If the "tmp" directories contain data, at some point that should also be discussed.

b. Page 14, section 6.2: The following should be briefly defined one at a time: Type, subtype, instance, host, port, data. The information currently listed should be kept, but that information needs to be expanded.

c. Page 15, section 6.3: Each heading (type, subtype, name, packetid, last recv) should be defined.

6. CONCLUSIONS.

6.1 HUMAN FACTORS CONCLUSIONS.

The Aviation Weather Research Products(AWRP), when considered individually and collectively as a single system, would provide improvements over current systems. However, if products are to be considered for potential incorporation into FAA systems, considerable additions and improvements would be necessary to address user needs and requests. The following paragraphs outline improvements for future development.

6.1.1 General Review Stage.

The AWRP interface and User's Guide are summarized in the following paragraphs.

a. The AWRP display and interface follow many human factors standards and guidelines; however, the display does need improvement in several areas as noted in paragraph 5.1.1.1. The interface should reflect job tasks and follow good design principles. A usable interface can improve performance and decrease controller error during critical high traffic periods.

b. The AWRP User's Guide provided a good description of the products; however, instructions regarding the user interface tended to be inconsistent and unclear. User guides are utilized as references and are rarely read in their entirety. Therefore, the guides should provide clear and concise explanations. Discussions of products and features should provide all required information. Referencing different sections should be kept to a minimum.

6.1.2 Operational Analysis Stage.

The operational analysis stage was conducted in order to determine how well the AWRP would perform in an operational environment.

6.1.2.1 Air Traffic User Working Group (ATUWG) and 1993 Demval Requests.

Users requested several products and features during ATUWG meetings and the 1993 Demval. The AWRP incorporated about half of the user requests from the ATUWG meetings. Color coding for each of the products and features were recommended by users. Several of these recommendations were not implemented. Additionally, several requests from the 1993 Demval were not incorporated in the AWRP.

While some user requests may be beyond the scope of the AWRP, they are based upon the needs of specialists and controllers in an operational setting. User meetings were intended to provide developers with feedback and weather information needs. Attention must be given to this information in the development of

future products in order to provide specialists with the required data presented in a useful format. Future systems intended for operational use will require these features.

6.1.2.2 Job Task Analysis (JTA) Weather Information Requirements.

The JTA comparison identified the following items:

a. Many pieces of weather information required by Automated Flight Service Station (AFSS) Preflight, Inflight, and Enroute Flight Advisory Specialists, as well as Air Route Traffic Control Center (ARTCC) Traffic Management Coordinators (TMC) were not available on the AWRP. This information is required to satisfy the needs of AFSS and ARTCC Traffic Management Unit (TMU) operational tasks.

b. The AWRP was assessed according to how well it overcame problems on current weather systems regarding information presentation and retrieval. The AWRP automatically plots weather advisories and provides winds aloft for more flight levels than current capabilities. However, the technology to parse advisories and plot information is not unique to the AWRP. Additionally, the ability to obtain winds aloft at more flight levels is a function of improved weather prediction models.

c. The AWRP does not overcome the JTA identified problems of comparing textual and graphical information, needing a graphical presentation of Pilot Reports (PIREPs), dealing with extensive textual information, or dealing with different interface formats. In order to acquire all required weather information, users would have to access other weather information systems. Additionally, the AWRP is not tailored to meet users' job tasks. In developing products to meet the needs for two user groups, the AWRP does not fully meet the needs of either user group.

While it is recognized that the current AWRP was not intended for operational use, operational requirements and users' needs were identified throughout the development of the AWRP. Failure to completely follow operational requirements and users' needs will result in future systems that do not provide the required weather information or present that information according to users' tasks.

6.2 METEOROLOGICAL CONCLUSIONS.

The meteorological evaluation identified improved data resolution and timeliness, and application of AWRP functions (e.g., zoom) as positive attributes of the AWRP. The improved data resolution and timeliness are a result of improved weather prediction models. The positive functions are available on many commercial vendor graphical weather systems. In addition, the real-time storm motions and forecasted icing potential of the AWRP offer capabilities not currently available to operational users. However, the meteorological evaluation identified significant interpretation issues concerning conflicting, absent, and fluctuating information. Specific conclusions about each phase of the meteorological evaluation are stated in the following paragraphs.

6.2.1 Meteorological Interpretation.

a. Conflicting information was presented when a mixture of automated and human derived products existed. For operational use, the two types of products must be reconciled. Otherwise, significant differences for the same parameter can be displayed leading to user confusion.

b. Graphical information was lacking. The graphical display of Airmen Meteorological Statements (AIRMETs) and Significant Meteorological Statements (SIGMETs) did not include characteristics of the phenomena of interest, such as vertical extent, type, and severity. Current operational graphical AFSS products include these characteristics.

c. The Flight Category product lacks forecast information. With only current observations, other weather information sources must be used in order to obtain the required forecast information.

d. The widely fluctuating storm area motions will likely lead to confusion. In addition, wide fluctuations tend to reduce the credibility of a product.

e. The AWRP display lacks information over large regions. Temperature contours have such wide spacing that significant interpretation was required in order to determine temperature at

locations. Flight Category information was only available for locations with hourly surface weather observations. No information was available at other locations.

f. The limitation of the horizontal plan view to a particular flight level limits the available information. Potential hazardous weather occurring directly below or above a flight level is not identified unless a user scans through multiple flight levels. The user must mentally interpolate and combine multiple levels into a mental composite picture.

6.2.2 Improvements.

Overall, it must be concluded that the AWRP offers few improvements over existing AFSS operational capabilities. The majority of the AWRP improvements were due to software functions that are available through commercial vendors and improved weather prediction models that provide input to the AWRP. The weather prediction models will likely provide more timely updates to existing operational platforms in the near future.

a. The AWRP demonstrated improvement over current AFSS capabilities by automating tasks that are currently performed by manual methods. The benefits are less interpretation, real-time availability, and avoidance of possible omissions of information to users.

b. The AWRP functions offer improvement over existing AFSS capabilities. However, commercial vendor graphical weather systems have similar functions.

c. The AWRP has improvements in spatial and temporal data resolution which are the result of improved weather prediction models that provide input to the AWRP. It is expected that commercial vendors will also take advantage of these resolution improvements.

d. The AWRP does not provide descriptive information on the graphical display of AIRMETs and SIGMETs which forces the user to search through textual information.

6.2.3 Meteorological Consistency.

During the AWRP evaluation, some inconsistencies were identified. If the AWRP were an operational system, the inconsistencies would be sufficient to cast doubt upon the reliability and accuracy of the AWRP. The major inconsistency was between the automated and human derived products as discussed previously in paragraph 6.2.1.a. The remainder of the discrepancies identified in the evaluation appeared to be caused by software errors that may be correctable by minor fixes. Examples of inconsistencies were discussed in paragraph 5.2.3.

6.3 SYSTEM ADMINISTRATOR CONCLUSIONS.

Inconsistencies in the AWRP installation and system management documentation were found. Such inconsistencies included:

a. Missing directory paths,
b. Incorrect directory listings, and
c. Lack of header definitions.

Examples of inconsistencies were discussed in paragraph 5.3.2.

7. RECOMMENDATIONS.

a. The display and interface should be improved if there is any consideration for use as a stand-alone system. However, if products are going to be ported to a different platform (i.e., vendor systems), improving the current interface would not be necessary. Problems with the current display and interface should be provided to CRDA vendors to ensure these problems are resolved in any future implementation of the products.

b. Improvements should be made to the User's Guide regarding manipulation of the interface.

c. User requests and feedback should be utilized in product development. The purpose of these meetings was to provide feedback regarding display format and weather information needs of users. This information should be used as the primary guidance in the development of the AWRP display.

d. Graphics need to present as much information as possible without forcing the user to search through text to find significant information.

e. As noted in the 1993 Demval Report, products and functions should be tailored for users.

f. Conflicting meteorological information must be avoided. Automated and human derived products must be reconciled if both are going to be displayed to nonmeteorologists. Either the automated should be used as guidance for a meteorologist in developing a product sent to the end user or the human derived product should be replaced with the automated product.

g. Automated meteorological forecasting techniques must produce stable results and minimize wide fluctuations that are difficult to interpret.

h. Thorough independent testing of the AWRP should be conducted before any new release of the software to CRDA vendors. The version of the AWRP evaluated in this report was released to CRDA vendors for possible integration onto existing platforms. Products having the amount of inconsistencies identified in the AWRP should not be considered for operational use.

i. Improvements should be made to the AWRP Installation and System Management Documentation.

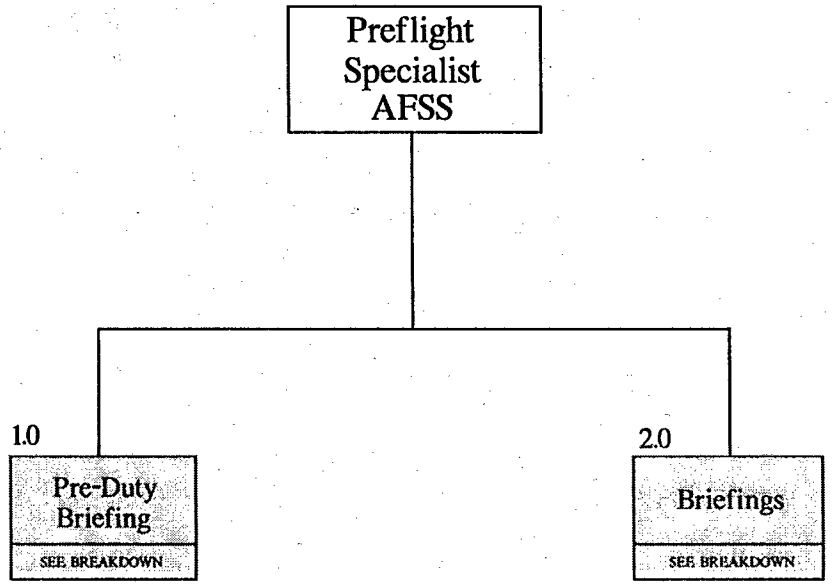
Despite the discrepancies noted, the AWRP products have the potential to provide controllers with much needed improvements in the area of Aviation Weather Information. Continued development of aviation weather graphical products and the underlying science is strongly recommended. However, consideration should be given to off-the-shelf commercial (COTS) weather products or the development of weather graphics by commercial vendors. NCAR's involvement in the rendering of products rather than the development of aviation weather science may not be the most efficient use of resources.

8. ACRONYMS.

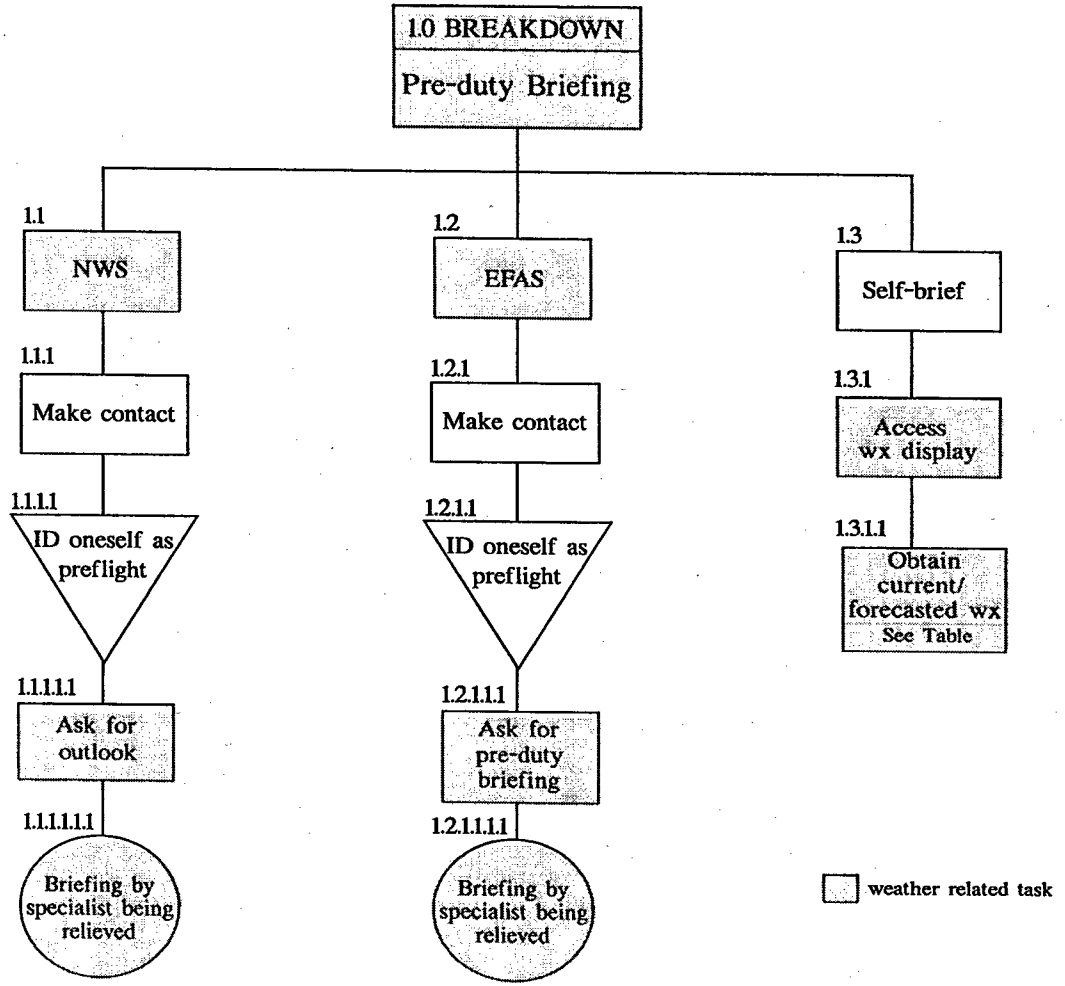
AFOTEC	-	Air Force Operational Test and Evaluation Center
AFSS	-	Automated Flight Service Station
AGFS	-	Aviation Gridded Forecast System
AIRMET	-	Airmen Meteorological Information
ARTCC	-	Air Route Traffic Control Center
ASD	-	Aircraft Situation Display
ASP	-	Airport Sequencing Program
ATUWG	-	Air Traffic User Working Group
AWPG	-	Aviation Weather Products Generator
AWC	-	Aviation Weather Center
AWR	-	Aviation Weather Research
AWRP	-	Aviation Weather Research Products
COTS	-	Commercial-off-the-shelf
CRDA	-	Cooperative Research and Development Agreement
CSU	-	Channel Service Unit
CWA	-	Center Weather Advisory
CWSU	-	Center Weather Service Unit
DEMVAL	-	Demonstration and Evaluation
DME	-	Distance Measuring Equipment
DOV	-	Dover, Delaware
DSTN	-	Destination
DSU	-	Data Service Unit
EFAS	-	Enroute Flight Advisory Specialist
ETA	-	Estimated Time of Arrival
ETD	-	Estimated Time of Departure
FAA	-	Federal Aviation Administration
FOS	-	Family Of Services
FSL	-	Forecast Systems Laboratory
FT	-	Terminal Forecast
GA	-	General Aviation
GOES	-	Geostationary Operational Environmental Satellite
GUI	-	Graphical User Interface
ID	-	Identification
IFR	-	Instrument Flight Rules
ILS	-	Instrument Landing System
IPT	-	Integrated Product Team
ITWS	-	Integrated Terminal Weather System
JTA	-	Job Task Analysis
K Index	-	Lifted Index
KBPS	-	Kilobytes per second

KBVT	-	Keyboard Video Terminal
km	-	Kilometers
LAA	-	Local Airport Advisory
LIFR	-	Low Instrument Flight Rules
LLWAS	-	Low Level Windshear Alert System
LOCN	-	Location
M1FC	-	Model 1 Full Capacity
MKE	-	Milwaukee, Wisconsin
MVFR	-	Marginal Visual Flight Rules
MWP	-	Meteorologist Weather Processor
NAVAID	-	Navigational Aid
NCAR	-	National Center for Atmospheric Research
NEXRAD	-	Next Generation Radar
NOTAM	-	Notice to Airmen
NWS	-	National Weather Service
PC	-	Personal Computer
PHL	-	Philadelphia, Pennsylvania
PIREP	-	Pilot Report
RADAT	-	Radio Sound Observation Data
RAREP	-	Radar Report
RH	-	Relative Humidity
RVR	-	Runway Visual Range
RVV	-	Runway Visibility Value
SAO	-	Surface Area Observation
SBY	-	Salisbury, Maryland
SIGMET	-	Significant Meteorological Information
TACAN	-	Tactical Air Navigation Station
TDWR	-	Terminal Doppler Weather Radar
TMC	-	Traffic Management Coordinator
TMU	-	Traffic Management Unit
TRACON	-	Terminal Radar Approach Control
TWEB	-	Transcribed Weather Broadcast
VFR	-	Visual Flight Rules
VHF	-	Very High Frequency
VOR	-	VHF Omnidirectional Range
VORTAC	-	VHF Omnidirectional Range TACAN
WA	-	Airmet
WARP	-	Weather And Radar Processor
WS	-	Sigmet
WX	-	Weather

APPENDIX A
JTA FLOWCHARTS AND TABLES



weather related task


1.0 BREAKDOWN
Pre-duty Briefing
1.1
NWS
1.1.1
Make contact
1.1.1.1
ID oneself as preflight
1.1.1.1.1
Ask for outlook
1.1.1.1.1.1
Briefing by specialist being relieved
1.2
EFAS
1.2.1
Make contact
1.2.1.1
ID oneself as preflight
1.2.1.1.1
Ask for pre-duty briefing
1.2.1.1.1.1
Briefing by specialist being relieved
1.3
Self-brief
1.3.1
Access wx display
1.3.1.1
Obtain current/ forecasted wx
See Table
weather related task

1.3.1.1 Obtain Current and Forecasted Weather

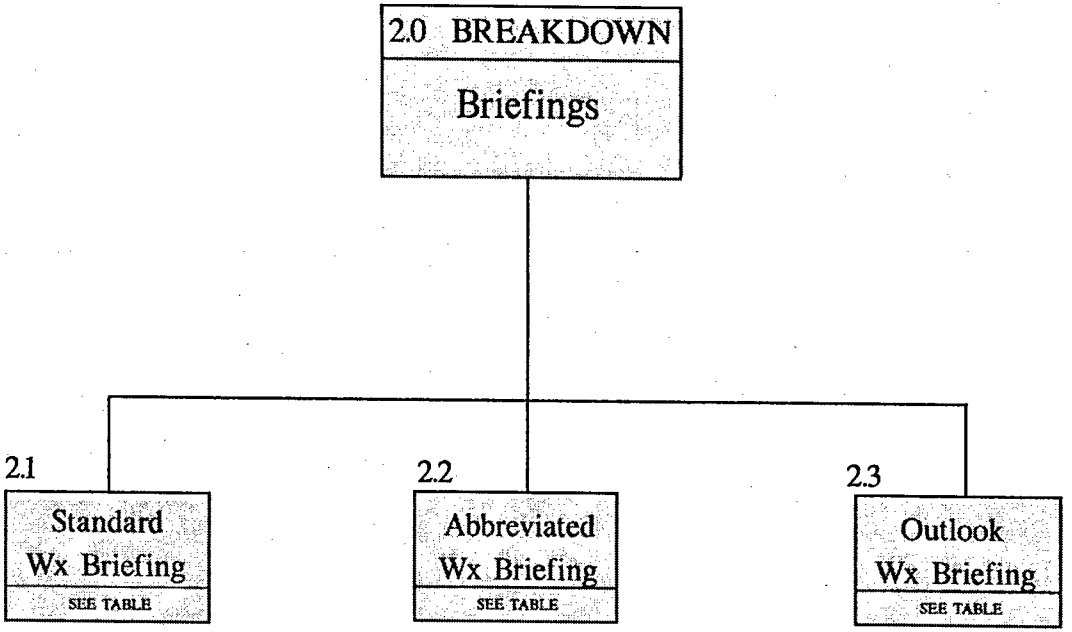
Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
Obtain adverse wx conditions	Perform self brief	M1FC and vendor graphic wx		Text and graphics	May cause pilot to change flight plan
Obtain LLWAS	Check for Approach and Departure	M1FC	Confirm using PIREPs	Text	Light aircraft may be affected by LLWAS
Obtain thunder-Storms	Check for Hazardous wx	M1FC, radar, and vendor graphic wx		Text and graphics	May cause change in flight plan
Obtain icing and turbulence	Check for Hazardous wx	M1FC, facility graphic wx and vendor graphic wx	Confirm with PIREPs/verify intensity	Text and graphics	May make change in altitude and flight plan necessary
Obtain weather Advisories	Check for Hazardous wx	M1FC and facility graphic wx	Confirm with radar and PIREPs	Text and graphics	May cause change in flight plan
Obtain weather depiction	Look for areas of VFR/IFR	M1FC and vendor graphic wx	Confirm using GOES and SA	Text and graphics	Look for IFR cond./alternate airport

1.3.1.1 Obtain Current and Forecasted Weather (Continued)

Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
Obtain synopsis	Provide locn and mvmt of wx systems	M1FC and vendor graphic wx	Compare to satellite imagery	Text and graphics	Check for new location of frontal zones
Obtain terminal forecast	Provide terminal area wx	M1FC	Compare to SA conditions and radar	Text	Update any changes since departure time
Obtain current conditions	Summarize SA, PIREPs, and RAREPs	M1FC and vendor graphics	Confirm using M1FC, PIREPs, and GOES	Text and graphics	Change in cond. May change flight plan
Obtain satellite imagery	Used to verify wx information	Vendor graphic wx	Compare to surface chart, SA, prog chart	Graphics	Aids in monitoring cloud movement
Obtain en-route wx forecast	Provide forecast along route	M1FC and vendor graphic wx	Comparing text and graphic information	Text and graphics	Wx info needed for en route and descent
Obtain area forecast	Provide forecast along route	M1FC	Compare wx from M1FC to radar and GOES	Text	Summary of forecast for area weather

1.3.1.1 Obtain Current and Forecasted Weather (Continued)

Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
View prognosis Charts	Provide forecast along route	Vendor graphic wx		Graphics	Aids in noting deviations btwn FA and FT
Obtain winds aloft	Provide wind speed and dir	M1FC and vendor graphic wx	Interpolate winds from M1FC btwn alt.	Text and graphics	Provides best altitude for route of flight
Obtain upper air moisture	Provides frzglvl, RH, K index	Vendor graphic wx	Compare to RADAT readings from M1FC	Graphic	May cause change in flight plan
Obtain PIREPs	Request for pilot reports	Radio request and M1FC	Used to confirm M1FC and vendor wx	Verbal info and text	Verifies any unforecasted wx conditions



weather related task

2.1 Standard Weather Briefing

Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
Obtain adverse wx conditions	Check adverse Wx that would affect flight	M1FC		Text	Adverse wx may alter flight plan
Obtain LLWAS	Check for Approach and Departure	M1FC	Confirm with PIREPs	Text	Light aircraft may be unable to navigate
Obtain thunder-Storms	Check for Hazardous wx	M1FC, radars, and vendor graphic wx		Text and graphics	May cause delay or alter flight plan
Obtain icing	Check for Hazardous wx	M1FC and facility graphic wx	Confirm with PIREPs and verify info	Text and graphics	May make change in alt. Necessary
Obtain weather advisories	Check for hazardous wx	M1FC and vendor graphic wx	Confirm with radar and PIREPs	Text and graphics	May cause delay or alter flight plan
Obtain weather depiction	Look for areas of VFR/IFR	Vendor graphic wx	Confirm using GOES and SA	Graphics	Look for IFR cond./alternate airport

2.1 Standard Weather Briefing (Continued)

Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
Obtain satellite imagery	Used to verify wx information	Vendor graphic wx	Compare to surface chart, SA, prog chart	Graphics	Monitoring of cloud coverage/ frontal zones
Obtain terminal forecast	Provides terminal area forecast	M1FC	Compare to SA conditions, and radar	Text	Provides wx in terminal area and airports
Obtain synopsis	Provide locn and mvmt of wx systems	M1FC and vendor graphic wx	Compare to satellite imagery	Text and graphics	Used for short and long range briefing
Obtain current Conditions	Summarize SA's, PIREPs, RAREPs	M1FC	Confirm using M1FC and PIREPs	Text	Used to create a summary of current wx
Obtain en-route wx forecast	Provide forecast along route	M1FC and vendor graphic wx	Comparing text and graphic information	Text and graphics	Provide wx for climb, en route, descent
Obtain area forecast	Provide forecast along route	M1FC	Compare wx from M1FC to radar	Text	Summarizes hazardous wx over area

2.1 Standard Weather Briefing (Continued)

Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
Look at prognosis Charts	Provide forecast along route	Vendor graphic wx		Graphics	Note deviations from FA and FT
Check destination forecast	Provide forecast wx for dstn.	M1FC		Text	Provides expected wx at destination
Obtain winds aloft	Provide wind speed and direction	M1FC and vendor graphic wx	Interpolate winds from M1FC btwn alt.	Text and graphics	Provide best altitude for flight
Obtain PIREPs	Request for pilot reports	Radio and M1FC	Used to confirm M1FC and vendor wx	Verbal info and text	Used to compare actual vs. forecast

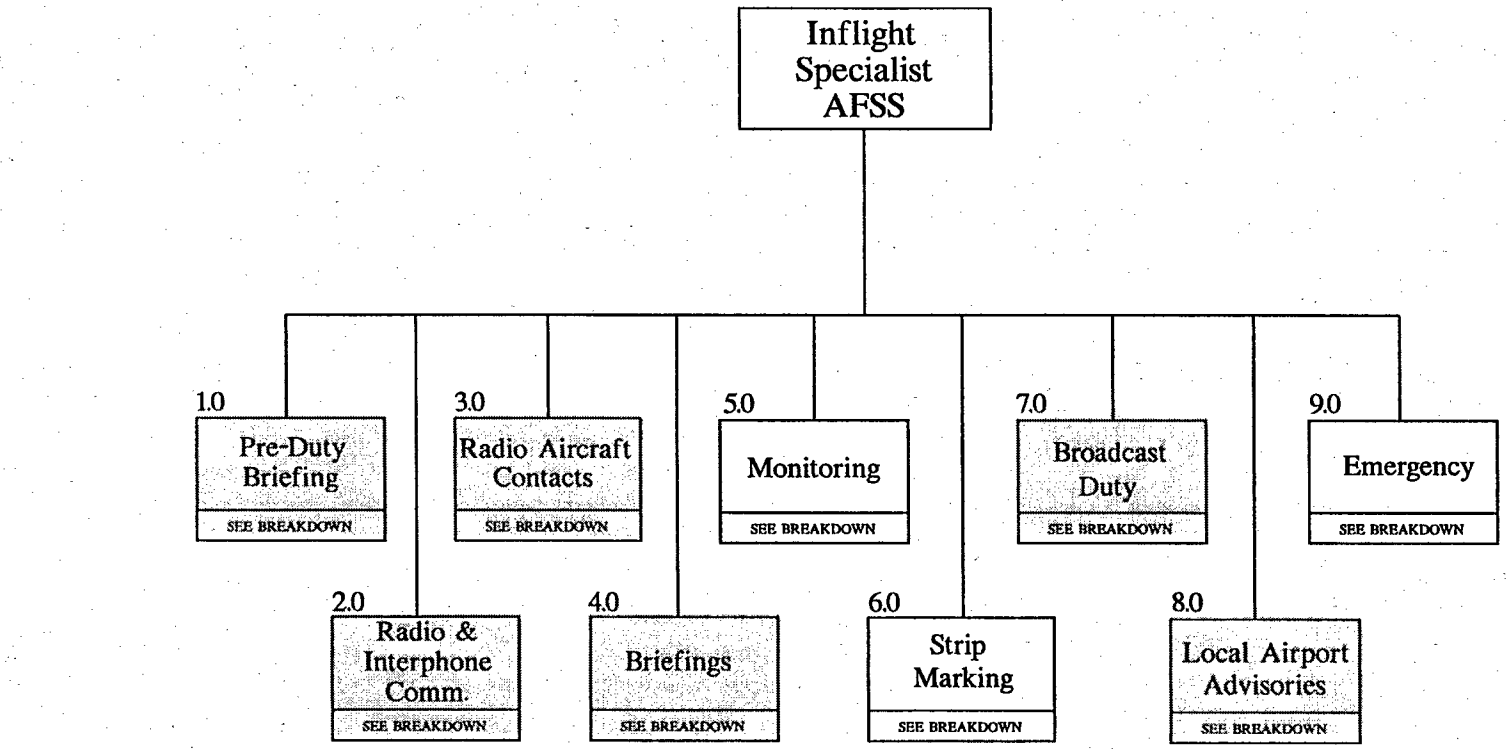
2.2 Abbreviated Weather Briefing

Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
Brief pilot On requested info	Provide pilot with requested wx	M1FC, vendor graphic wx, and radars		Text and graphics	Give data not recieved in earlier brief
Obtain adverse wx information	Provide pilot with adverse wx conditions	M1FC and vendor graphic wx		Text and graphics	May cause change in flight plan
Update pilot info if new info avail.	Provide new wx since last brief	M1FC and vendor graphic wx		Text and graphics	May cause change in flight plan
Solicit pilot reports	Need for pilot reported wx	M1FC and radio contact	Used to confirm M1FC and vendor wx	Text and verbal information	Used to check for un-forecasted wx

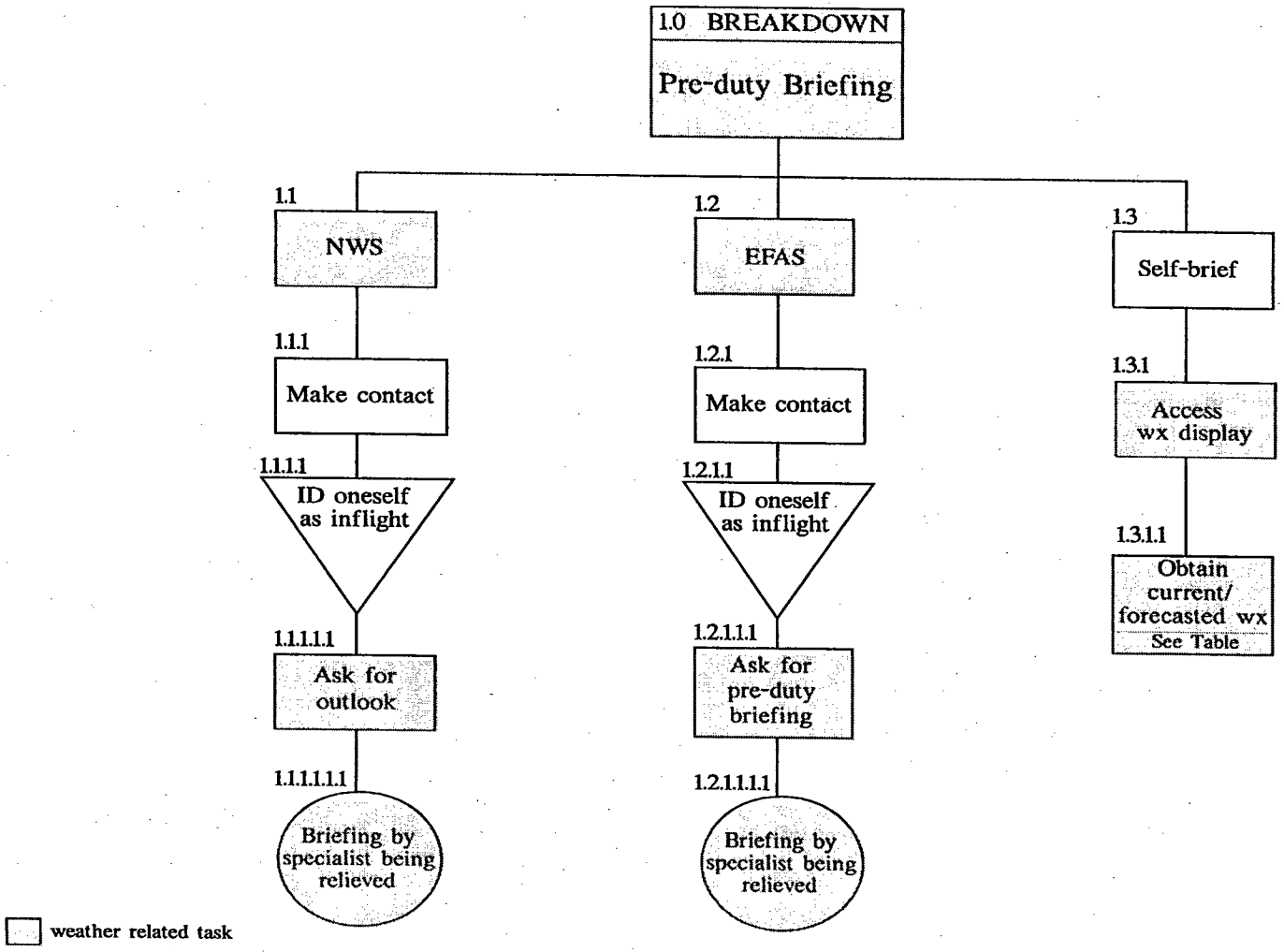
2.3 Outlook Briefing

Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
Obtain adverse weather	provide pilot with forecast adverse wx	M1FC and vendor graphic wx		Text and graphics	Provide pilot with weather update
Obtain weather depiction	recommend VFR/IFR	M1FC and vendor graphic wx	Confirm with GOES and SA	Text and graphics	Look for area IFR/VFR conditions
Obtain synopsis	statement of locn and mvmt of wx masses	M1FC and vendor graphic wx		Text and graphics	Check for frontal zone/ alter flight
Obtain en-route forecast	provide forecast along route	M1FC and vendor graphic wx	Comparing text and graphic wx information	Text and graphics	May cause change in flight plan
Check destination forecast	provide forecast for destination	M1FC and vendor graphic wx		Text and graphics	May need alternate airport

Inflight Specialists JTA



weather related task


1.0 BREAKDOWN
Pre-duty Briefing
1.1
NWS
1.1.1
Make contact
1.1.1.1
ID oneself as inflight
1.1.1.1.1
Ask for outlook
1.1.1.1.1.1
Briefing by specialist being relieved
1.2
EFAS
1.2.1
Make contact
1.2.1.1
ID oneself as inflight
1.2.1.1.1
Ask for pre-duty briefing
1.2.1.1.1.1
Briefing by specialist being relieved
1.3
Self-brief
1.3.1
Access wx display
1.3.1.1
Obtain current/ forecasted wx
See Table
weather related task

1.3.1.1 Obtain Current and Forecasted Weather

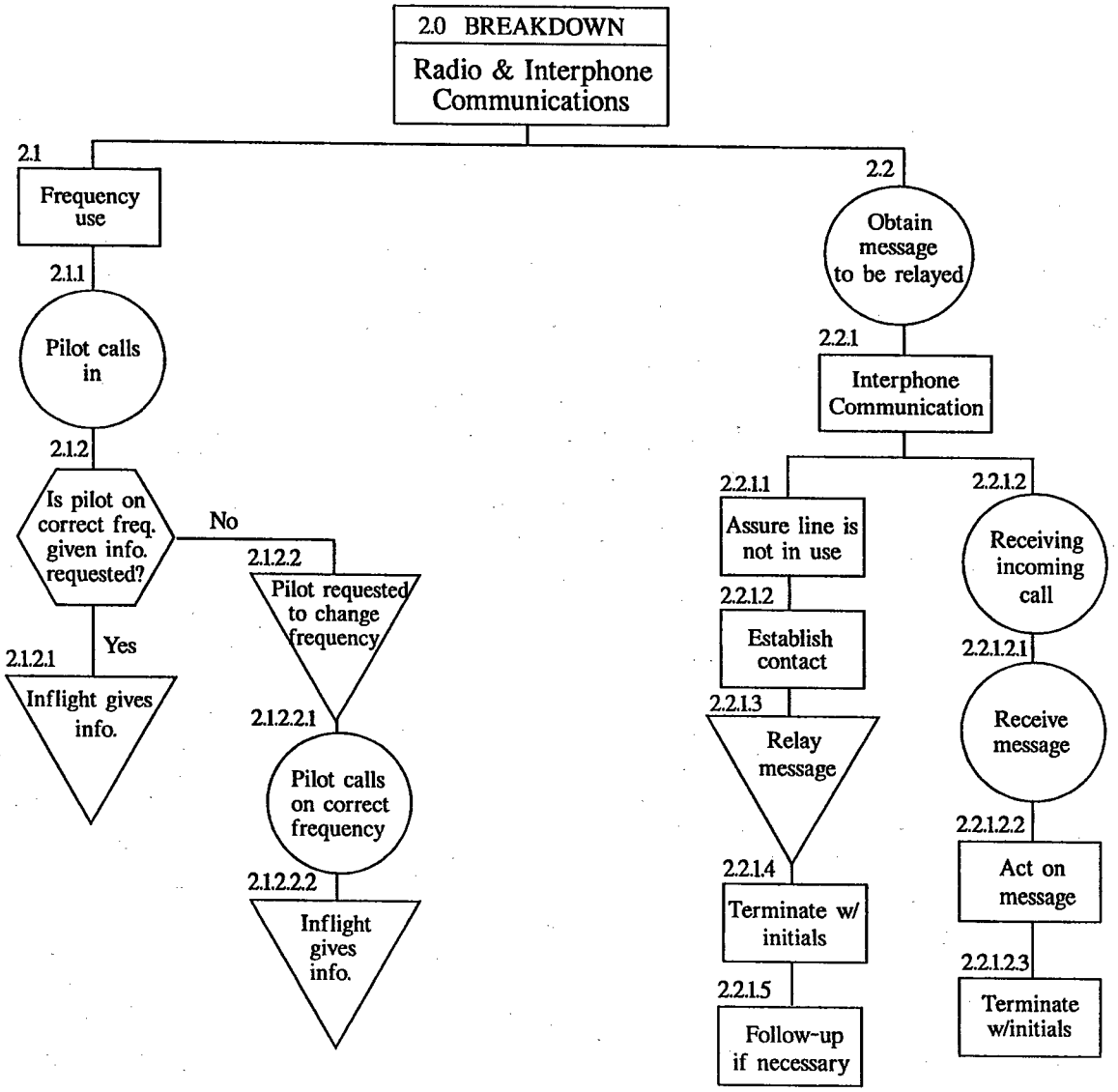
Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
Obtain adverse wx conditions	Perform self brief	M1FC and vendor graphic wx		Text and graphics	may cause pilot to change flight plan
Obtain LLWAS	Check for Approach and Departure	M1FC	Confirm using PIREPs	Text	light aircraft may be affected by LLWAS
Obtain thunder-Storms	Check for Hazardous wx	M1FC, radar, and vendor graphic wx		Text and graphics	may cause change in flight plan
Obtain icing and turbulence	Check for Hazardous wx	M1FC, facility graphic wx and vendor graphics weather	Confirm with PIREPs/verify intensity	Text and graphics	may make change in altitude and flight plan necessary
Obtain weather Advisories	Check for Hazardous wx	M1FC and facility graphic wx	Confirm with radar and PIREPs	Text and graphics	may cause change in flight plan

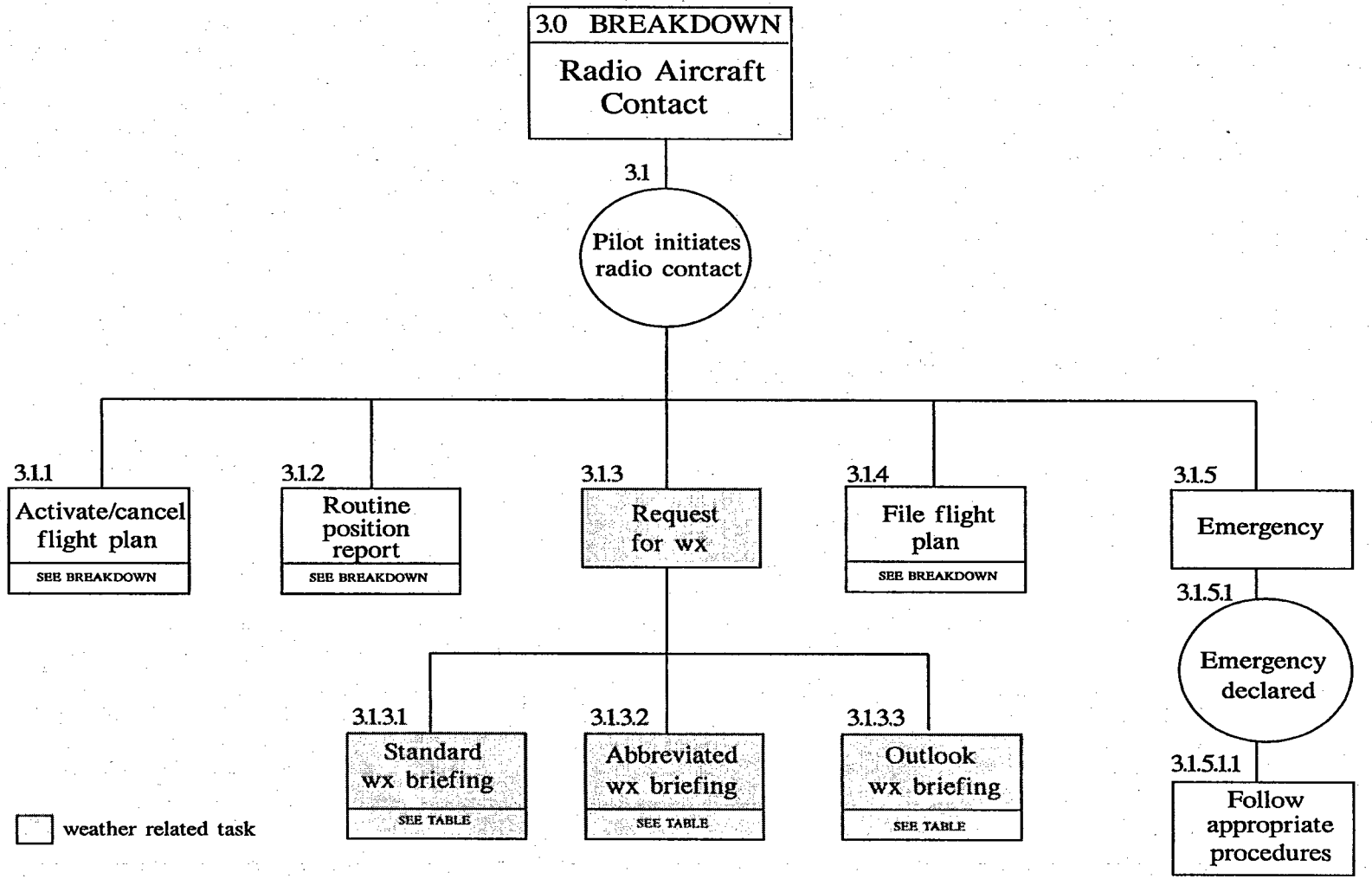
1.3.1.1 Obtain Current and Forecasted Weather (Continued)

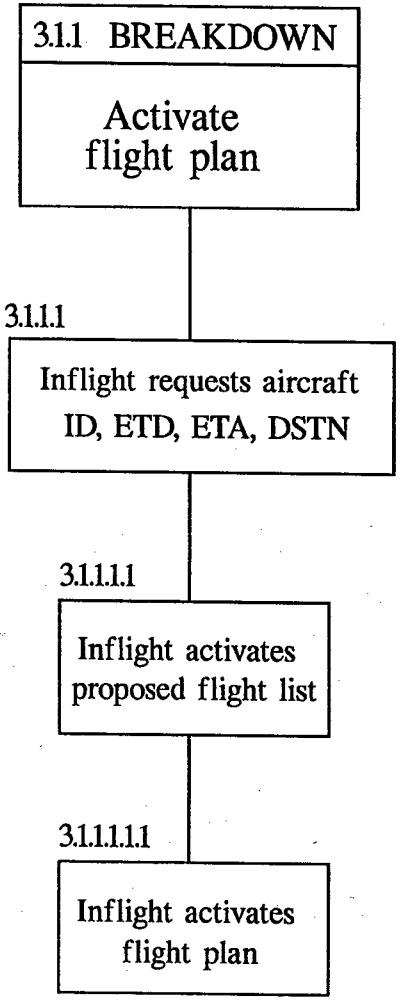
Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
Obtain weather depiction	Look for areas of VFR/IFR	M1FC and vendor graphic wx	Confirm using GOES and SA	Text and graphics	Look for IFR cond./alternate airport
Obtain synopsis	Provide locn and mvmt of wx systems	M1FC and vendor graphic wx	Compare to satellite imagery	Text and graphics	Check for new location of frontal zones
Obtain terminal forecast	Provide terminal area wx	M1FC	Compare to SA conditions and radar	Text	Update any changes since departure time
Obtain current conditions	Summarize SA, PIREPs, and RAREPs	M1FC and vendor graphics	Confirm using M1FC, PIREPs, and GOES	Text and graphics	Change in cond. May change flight plan
Obtain satellite imagery	Used to verify wx information	Vendor graphic wx	Compare to surface chart, SA, prog chart	Graphics	Aids in monitoring cloud movement
Obtain en-route wx forecast	Provide forecast along route	M1FC and vendor graphic wx	Comparing text and graphic information	Text and graphics	Wx info needed for en route and descent

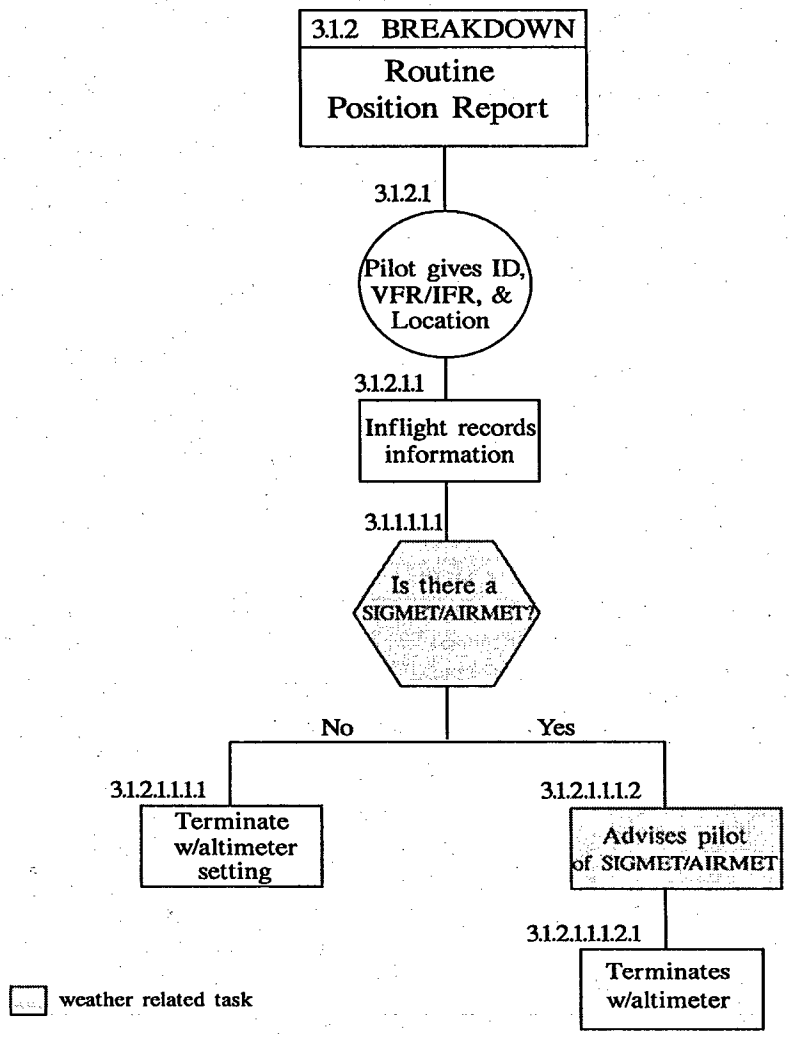
1.3.1.1 Obtain Current and Forecasted Weather (Continued)

Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
Obtain area forecast	provide forecast along route	M1FC	Compare wx from M1FC to radar and GOES	Text	Summary of forecast for area weather
View prognosis Charts	provide forecast along route	Vendor graphic wx		Graphics	Aids in noting deviations btwn FA and FT
Obtain winds aloft	provide wind speed and dir	M1FC and vendor graphic wx	Interpolate winds from M1FC btwn alt.	Text and graphics	Provides best altitude for route of flight
Obtain upper air moisture	provides frzglvl, RH, K index	Vendor graphic wx	Compare to RADAT readings from M1FC	Graphic	May cause change in flight plan
Obtain PIREPs	request for pilot reports	Radio request and M1FC	Used to confirm M1FC and vendor wx	Verbal info and text	Verifies any unforecasted wx conditions


2.0 BREAKDOWN
Radio & Interphone Communications
2.1
Frequency use
2.1.1
Pilot calls in
2.1.2
Is pilot on correct freq. given info. requested?
No
2.1.2.2
Pilot requested to change frequency
2.1.2.2.1
Pilot calls on correct frequency
2.1.2.2.2
Inflight gives info.
Yes
2.1.2.1
Inflight gives info.
2.2
Obtain message to be relayed
2.2.1
Interphone Communication
2.2.1.1
Assure line is not in use
2.2.1.2
Establish contact
2.2.1.3
Relay message
2.2.1.4
Terminate w/ initials
2.2.1.5
Follow-up if necessary
2.2.1.2
Receiving incoming call
2.2.1.2.1
Receive message
2.2.1.2.2
Act on message
2.2.1.2.3
Terminate w/initials


3.0 BREAKDOWN
Radio Aircraft Contact
3.1
Pilot initiates radio contact
3.1.1
Activate/cancel flight plan
SEE BREAKDOWN
3.1.2
Routine position report
SEE BREAKDOWN
3.1.3
Request for wx
3.1.4
File flight plan
SEE BREAKDOWN
3.1.5
Emergency
3.1.5.1
Emergency declared
3.1.5.1.1
Follow appropriate procedures
3.1.3.1
Standard wx briefing
SEE TABLE
3.1.3.2
Abbreviated wx briefing
SEE TABLE
3.1.3.3
Outlook wx briefing
SEE TABLE
weather related task


3.1.1 BREAKDOWN
Activate flight plan
3.1.1.1
Inflight requests aircraft ID, ETD, ETA, DSTN
3.1.1.1.1
Inflight activates proposed flight list
3.1.1.1.1.1
Inflight activates flight plan


3.1.2 BREAKDOWN
Routine Position Report
3.1.2.1
Pilot gives ID, VFR/IFR, & Location
3.1.2.1.1
Inflight records information
3.1.1.1.1.1
Is there a SIGMET/AIRMET?
No
Yes
3.1.2.1.1.1.1
Terminate w/altimeter setting
3.1.2.1.1.1.2
Advises pilot of SIGMET/AIRMET
3.1.2.1.1.1.2.1
Terminates w/altimeter
weather related task

3.1.3.1 Standard Weather briefing

Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
Obtain adverse wx conditions	Check adverse Wx that would affect flight	M1FC		Text	Adverse wx may alter flight plan
Obtain LLWAS	Check for Approach and Departure	M1FC	Confirm with PIREPs	Text	Light aircraft may be unable to navigate
Obtain thunder-Storms	Check for Hazardous wx	M1FC, radars, and vendor graphic wx		Text and graphics	May cause delay or alter flight plan
Obtain icing	Check for Hazardous wx	M1FC and facility graphic wx	Confirm with PIREPs and verify info	Text and graphics	May make change in alt. Necessary
Obtain weather advisories	Check for hazardous wx	M1FC and vendor graphic wx	Confirm with radar and PIREPs	Text and graphics	May cause delay or alter flight plan
Obtain weather depiction	Look for areas of VFR/IFR	Vendor graphic wx	Confirm using GOES and SA	Graphics	Look for IFR cond./alternate airport

3.1.3.1 Standard Weather Briefing (Continued)

Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
Obtain satellite imagery	used to verify wx information	Vendor graphic wx	Compare to surface chart, SA, prog chart	Graphics	Monitoring of cloud coverage/ frontal zones
Obtain terminal forecast	provides terminal area forecast	M1FC	Compare to SA conditions, and radar	Text	Provides wx in terminal area and airports
Obtain synopsis	provide locn and mvmt of wx systems	M1FC and vendor graphic wx	Compare to satellite imagery	Text and graphics	Used for short and long range briefing
Obtain current Conditions	summarize SA's, PIREPs, RAREPs	M1FC	Confirm using M1FC and PIREPs	Text	Used to create a summary of current wx
Obtain en-route wx forecast	provide forecast along route	M1FC and vendor graphic wx	Comparing text and graphic information	Text and graphics	Provide wx for climb, en route, descent
Obtain area forecast	provide forecast along route	M1FC	Compare wx from M1FC to radar	Text	Summarizes hazardous wx over area

3.1.3.1 Standard Weather Briefing (Continued)

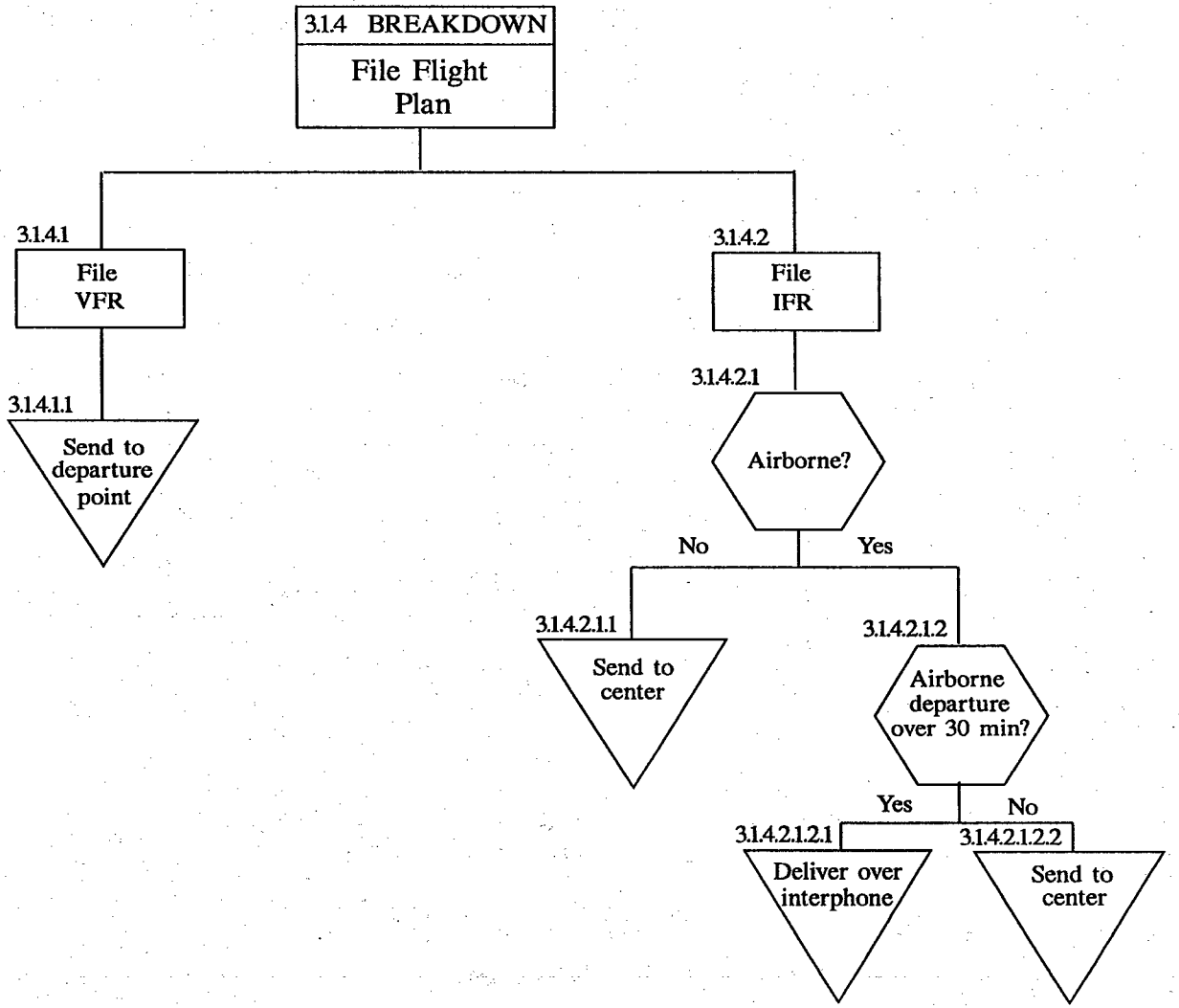
Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
Look at prognosis Charts	Provide forecast along route	Vendor graphic wx		Graphics	Note deviations from FA and FT
Check destination forecast	Provide forecast wx for dstn.	M1FC		Text	Provides expected wx at destination
Obtain winds aloft	Provide wind speed and direction	M1FC and vendor graphic wx	Interpolate winds from M1FC btwn alt.	Text and graphics	Provide best altitude for flight
Obtain PIREPs	Request for pilot reports	Radio and M1FC	Used to confirm M1FC and vendor wx	Verbal info and text	Used to compare actual vs. forecast

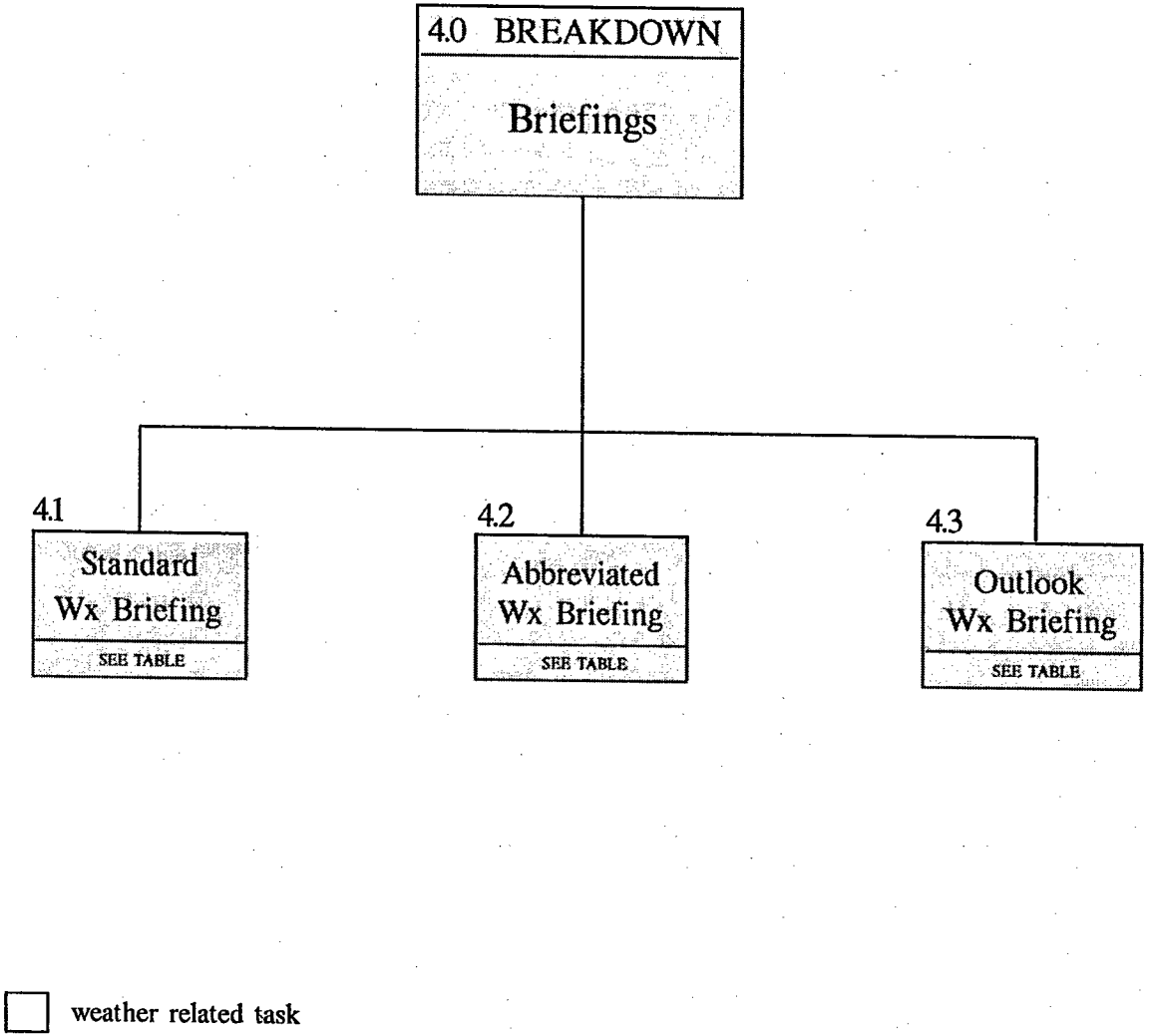
3.1.3.2 Abbreviated Weather Briefing

Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
Brief pilot On requested info	Provide pilot with requested wx	M1FC, vendor graphic wx, and radars		Text and graphics	Give data not recieved in earlier brief
Obtain adverse wx information	Provide pilot with adverse wx conditions	M1FC and vendor graphic wx		Text and graphics	May cause change in flight plan
Update pilot info if new info avail.	Provide new wx since last brief	M1FC and vendor graphic wx		Text and graphics	May cause change in flight plan
Solicit pilot reports	Need for pilot reported wx	M1FC and radio contact	Used to confirm M1FC and vendor wx	Text and verbal information	Used to check for un-forecasted wx

3.1.3.3 Outlook Briefing

Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
Obtain adverse weather	Provide pilot with forecast adverse wx	M1FC and vendor graphic wx		Text and graphics	Provide pilot with weather update
Obtain weather depiction	Recommend VFR/IFR	M1FC and vendor graphic wx	Confirm with GOES and SA	Text and graphics	Look for area IFR/VFR conditions
Obtain synopsis	Statement of locn and mvmt of wx masses	M1FC and vendor graphic wx		Text and graphics	Check for frontal zone/ alter flight
Obtain en-route forecast	Provide forecast along route	M1FC and vendor graphic wx	Comparing text and graphic wx information	Text and graphics	May cause change in flight plan
Check destination forecast	Provide forecast for destination	M1FC and vendor graphic wx		Text and graphics	May need alternate airport


3.1.4 BREAKDOWN
File Flight Plan
3.1.4.1
File VFR
3.1.4.1.1
Send to departure point
3.1.4.2
File IFR
3.1.4.2.1
Airborne?
No
Yes
3.1.4.2.1.1
Send to center
3.1.4.2.1.2
Airborne departure over 30 min?
Yes
No
3.1.4.2.1.2.1
Deliver over interphone
3.1.4.2.1.2.2
Send to center


4.0 BREAKDOWN
Briefings
4.1
Standard
Wx Briefing
SEE TABLE
4.2
Abbreviated
Wx Briefing
SEE TABLE
4.3
Outlook
Wx Briefing
SEE TABLE
weather related task

4.1 Standard Weather Briefing

Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
Obtain adverse wx conditions	Check adverse Wx that would affect flight	M1FC		Text	Adverse wx may alter flight plan
Obtain LLWAS	Check for Approach and Departure	M1FC	Confirm with PIREPs	Text	Light aircraft may be unable to navigate
Obtain thunder-storms	Check for Hazardous wx	M1FC, radars, And vendor graphic wx		Text and graphics	May cause delay or alter flight plan
Obtain icing	Check for Hazardous wx	M1FC and facility graphic wx	Confirm with PIREPs and verify info	Text and graphics	May make change in alt. Necessary
Obtain weather advisories	Check for hazardous wx	M1FC and vendor graphic wx	Confirm with radar and PIREPs	Text and graphics	May cause delay or alter flight plan
Obtain weather depiction	Look for areas of VFR/IFR	Vendor graphic wx	Confirm using GOES and SA	Graphics	Look for IFR cond./alternate airport

4.1 Standard Weather Briefing (Continued)

Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
Obtain satellite imagery	Used to verify wx information	Vendor graphic wx	Compare to surface chart, SA, prog chart	Graphics	Monitoring of cloud coverage/ frontal zones
Obtain terminal forecast	Provides terminal area forecast	M1FC	Compare to SA conditions, and radar	Text	Provides wx in terminal area and airports
Obtain synopsis	Provide locn and mvmt of wx systems	M1FC and vendor graphic wx	Compare to satellite imagery	Text and graphics	Used for short and long range briefing
Obtain current Conditions	Summarize SA's, PIREPs, RAREPs	M1FC	Confirm using M1FC and PIREPs	Text	Used to create a summary of current wx
Obtain en-route wx forecast	Provide forecast along route	M1FC and vendor graphic wx	Comparing text and graphic information	Text and graphics	Provide wx for climb, en route, descent
Obtain area forecast	Provide forecast along route	M1FC	Compare wx from M1FC to radar	Text	Summarizes hazardous wx over area

4.1 Standard Weather Briefing (Continued)

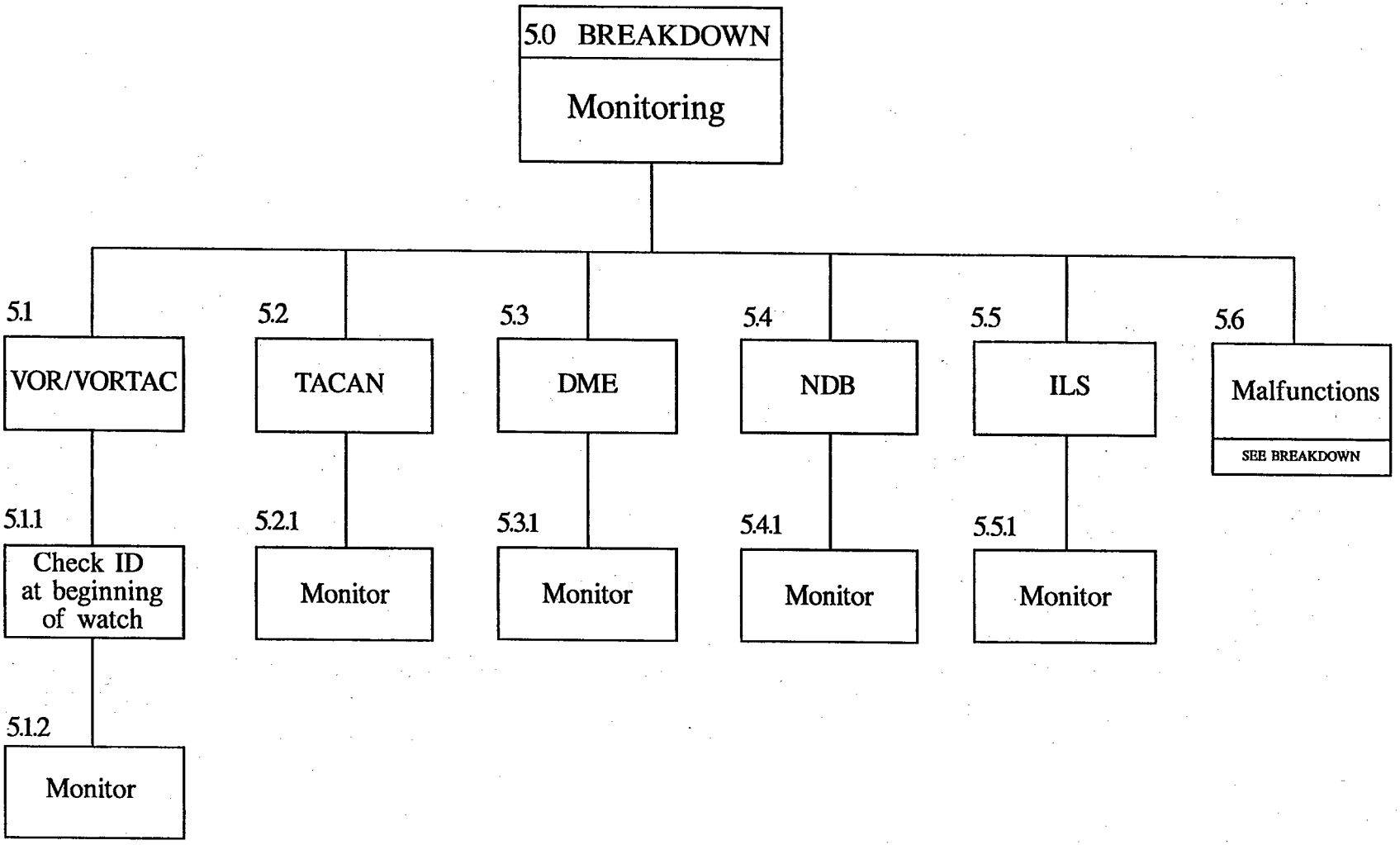
Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
Look at prognosis Charts	Provide forecast along route	Vendor graphic wx		Graphics	Note deviations from FA and FT
Check destination forecast	Provide forecast wx for dstn.	M1FC		Text	Provides expected wx at destination
Obtain winds aloft	Provide wind speed and direction	M1FC and vendor graphic wx	Interpolate winds from M1FC btwn alt.	Text and graphics	Provide best altitude for flight
Obtain PIREPs	Request for pilot reports	Radio and M1FC	Used to confirm M1FC and vendor wx	Verbal info and text	Used to compare actual vs. forecast

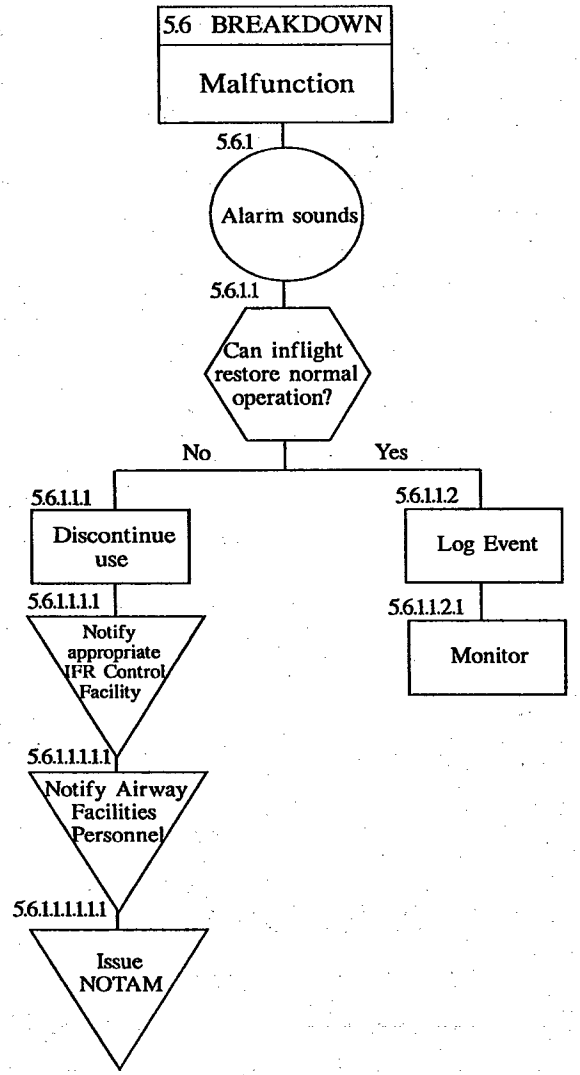
4.2 Abbreviated Weather Briefing

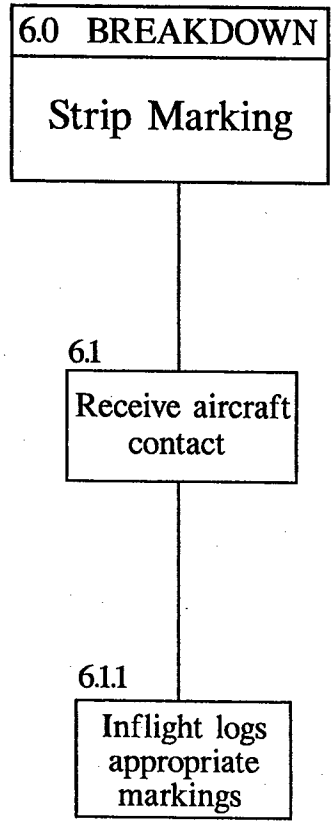
Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
Brief pilot On requested info	Provide pilot with requested wx	M1FC, vendor graphic wx, and radars		Text and graphics	Give data not recieved in earlier brief
Obtain adverse wx information	Provide pilot with adverse wx conditions	M1FC and vendor graphic wx		Text and graphics	May cause change in flight plan
Update pilot info if new info avail.	Provide new wx since last brief	M1FC and vendor graphic wx		Text and graphics	May cause change in flight plan
Solicit pilot reports	Need for pilot reported wx	M1FC and radio contact	Used to confirm M1FC and vendor wx	Text and verbal information	Used to check for un-forecasted wx

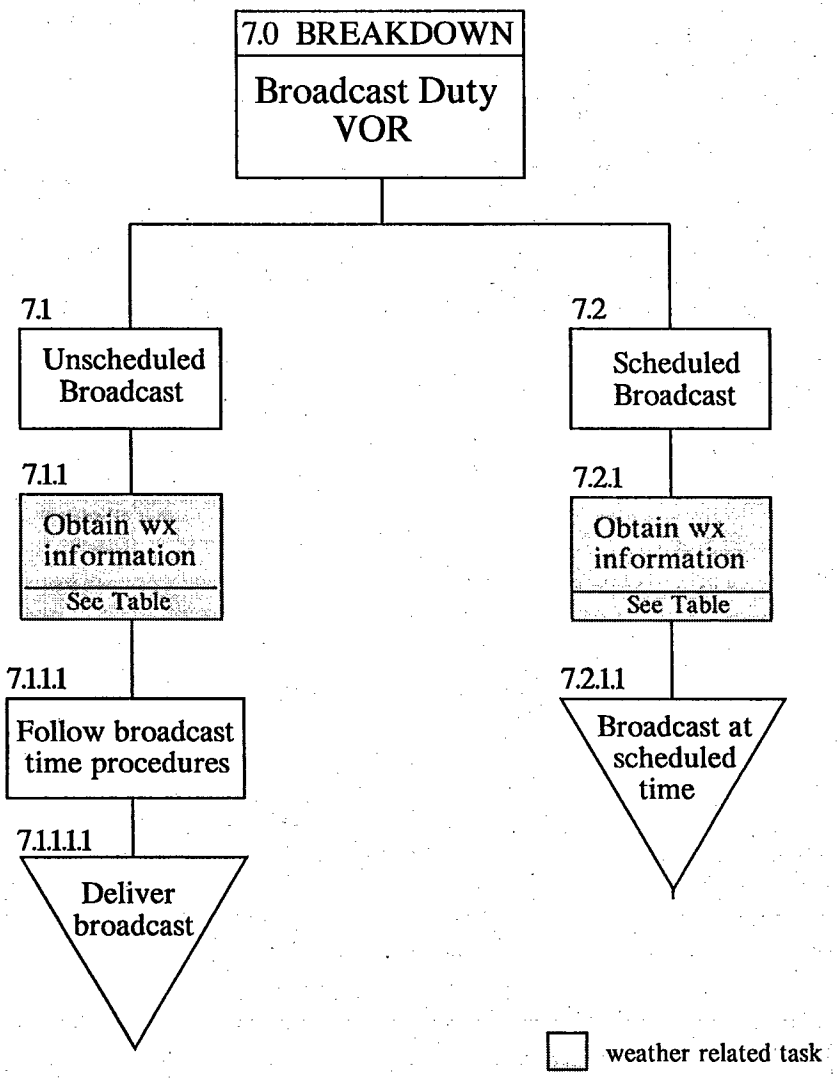
4.3 Outlook Briefing

Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
Obtain adverse weather	Provide pilot with forecast adverse wx	M1FC and vendor graphic wx		Text and graphics	Provide pilot with weather update
Obtain weather depiction	Recommend VFR/IFR	M1FC and vendor graphic wx	Confirm with GOES and SA	Text and graphics	Look for area IFR/VFR conditions
Obtain synopsis	Statement of locn and mvmt of wx masses	M1FC and vendor graphic wx		Text and graphics	Check for frontal zone/ alter flight
Obtain en-route forecast	Provide forecast along route	M1FC and vendor graphic wx	Comparing text and graphic wx information	Text and graphics	May cause change in flight plan
Check destination forecast	Provide forecast for destination	M1FC and vendor graphic wx		Text and graphics	May need alternate airport


5.0 BREAKDOWN
Monitoring
5.1
VOR/VORTAC
5.1.1
Check ID at beginning of watch
5.1.2
Monitor
5.2
TACAN
5.2.1
Monitor
5.3
DME
5.3.1
Monitor
5.4
NDB
5.4.1
Monitor
5.5
ILS
5.5.1
Monitor
5.6
Malfunctions
SEE BREAKDOWN


5.6 BREAKDOWN
Malfunction
5.6.1
Alarm sounds
5.6.1.1
Can inflight restore normal operation?
No
Yes
5.6.1.1.1
Discontinue use
5.6.1.1.2
Log Event
5.6.1.1.1.1
Notify appropriate IFR Control Facility
5.6.1.2.1
Monitor
5.6.1.1.1.1.1
Notify Airway Facilities Personnel
5.6.1.1.1.1.1.1
Issue NOTAM


6.0 BREAKDOWN
Strip Marking
6.1
Receive aircraft contact
6.1.1
Inflight logs appropriate markings


7.0 BREAKDOWN
Broadcast Duty VOR
7.1
Unscheduled Broadcast
7.1.1
Obtain wx information
See Table
7.1.1.1
Follow broadcast time procedures
7.1.1.1.1
Deliver broadcast
7.2
Scheduled Broadcast
7.2.1
Obtain wx information
See Table
7.2.1.1
Broadcast at scheduled time
weather related task

7.1.1 Obtain weather information

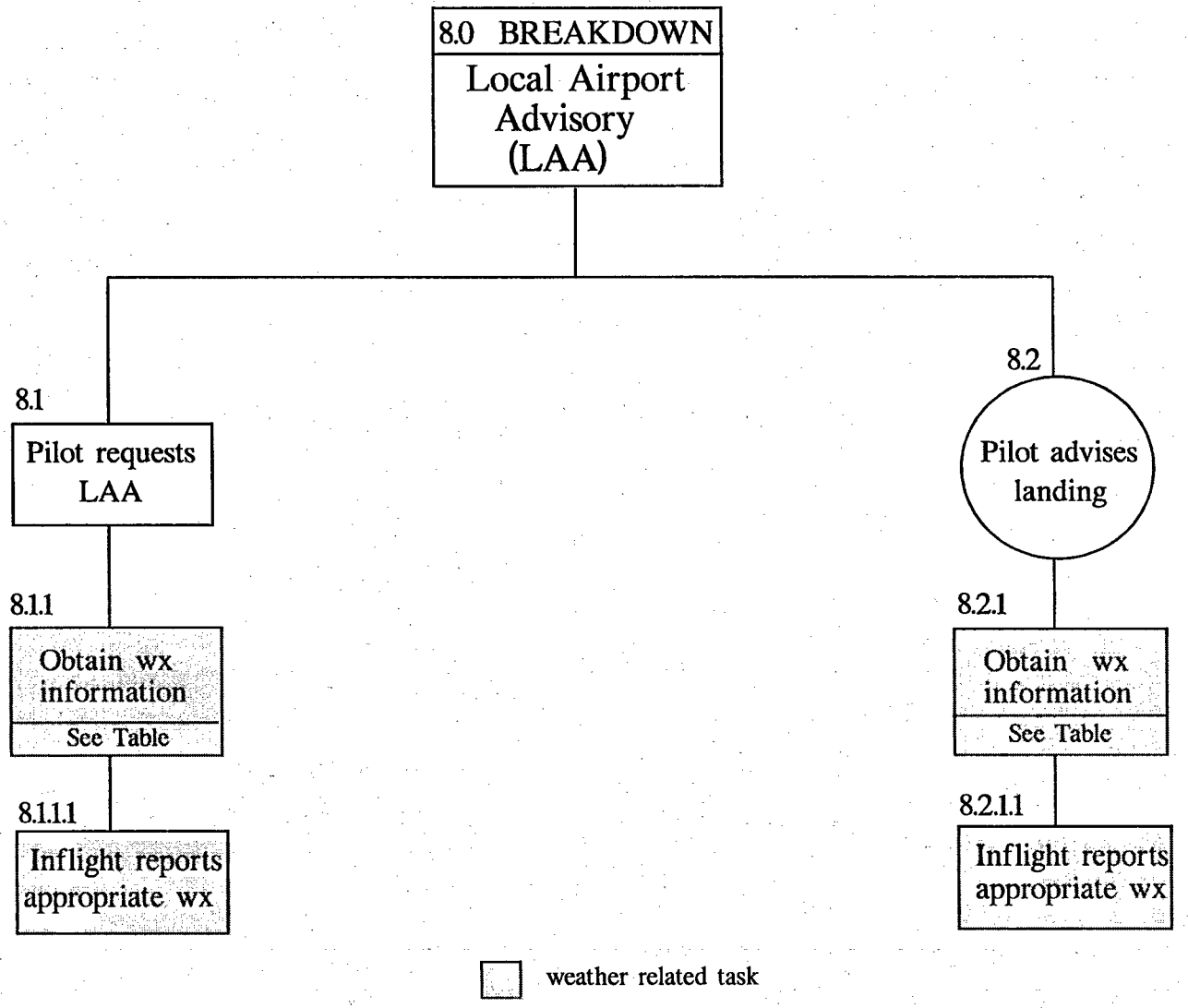
Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
Obtain convective SIGMET	Issue hazardous wx	M1FC and facility made graphic wx		Text and graphics	Data is disseminated in broadcast
Obtain SIGMET	Issue hazardous wx	M1FC and facility made graphic wx		Text and graphics	Data is disseminated in broadcast
Obtain AIRMET	Issue hazardous wx	M1FC and facility made graphic wx		Text and graphics	Data is disseminated in broadcast
Obtain Center Wx Advisory	Issue hazardous wx	M1FC and facility made graphic wx		Text and graphics	Data is disseminated in broadcast
Obtain Severe Wx Watch	Issue hazardous wx	M1FC and facility made graphic wx		Text and graphics	Data is disseminated in broadcast

7.2.1 Obtain Weather Information

Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
Obtain Synopsis	Issue hazardous wx	M1FC and vendor graphic wx		Text and graphics	Provides hazardous wx for broadcast
Obtain convective SIGMET	Issue hazardous wx	M1FC and facility made graphic wx		Text and graphics	Provides hazardous wx for broadcast
Obtain SIGMET	Issue hazardous wx	M1FC and facility made graphic wx		Text and graphics	Provides hazardous wx for broadcast
Obtain AIRMET	Issue hazardous wx	M1FC and facility made graphic wx		Text and graphics	Provides hazardous wx for broadcast
Obtain Center Wx Advisory	Issue hazardous wx	M1FC and facility made graphic wx		Text and graphics	Provides hazardous wx for broadcast
Obtain Severe Wx Watch	Issue hazardous wx	M1FC and facility made graphic wx		Text and graphics	Provides hazardous wx for broadcast

7.2.1 Obtain Weather Information (Continued)

Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
Obtain TWEB route forecast	Issue hazardous wx	M1FC and vendor graphic wx		Text and graphics	Provide route wx for broadcast
Obtain winds aloft	Issue hazardous wx	M1FC and vendor graphic wx	No interpolation performed	Text and graphics	Provide winds at 3000-18000 ft.
Obtain radar reports	Issue hazardous wx	M1FC		Text	Provide precip. For broadcast area
Obtain surface wx reports	Issue hazardous wx	M1FC		Text	Provides surface obs for broadcast area
Obtain PIREPs	Issue hazardous wx	M1FC	Used to confirm wx information	Text	Used to alert pilots of conditions
Obtain density altitude	Issue wx info	Text table from book		Text/ numerical	Conditional info given wx

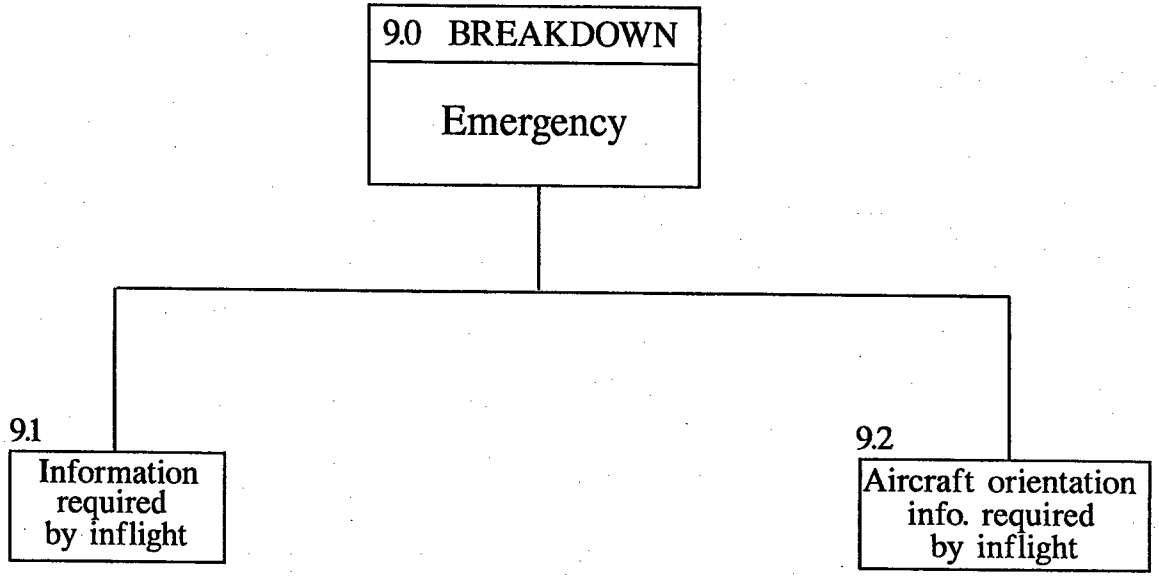

8.0 BREAKDOWN
Local Airport Advisory (LAA)
8.1
Pilot requests LAA
8.1.1
Obtain wx information
See Table
8.1.1.1
Inflight reports appropriate wx
8.2
Pilot advises landing
8.2.1
Obtain wx information
See Table
8.2.1.1
Inflight reports appropriate wx
weather related task

8.1.1/8.2.1 Obtain Weather Information

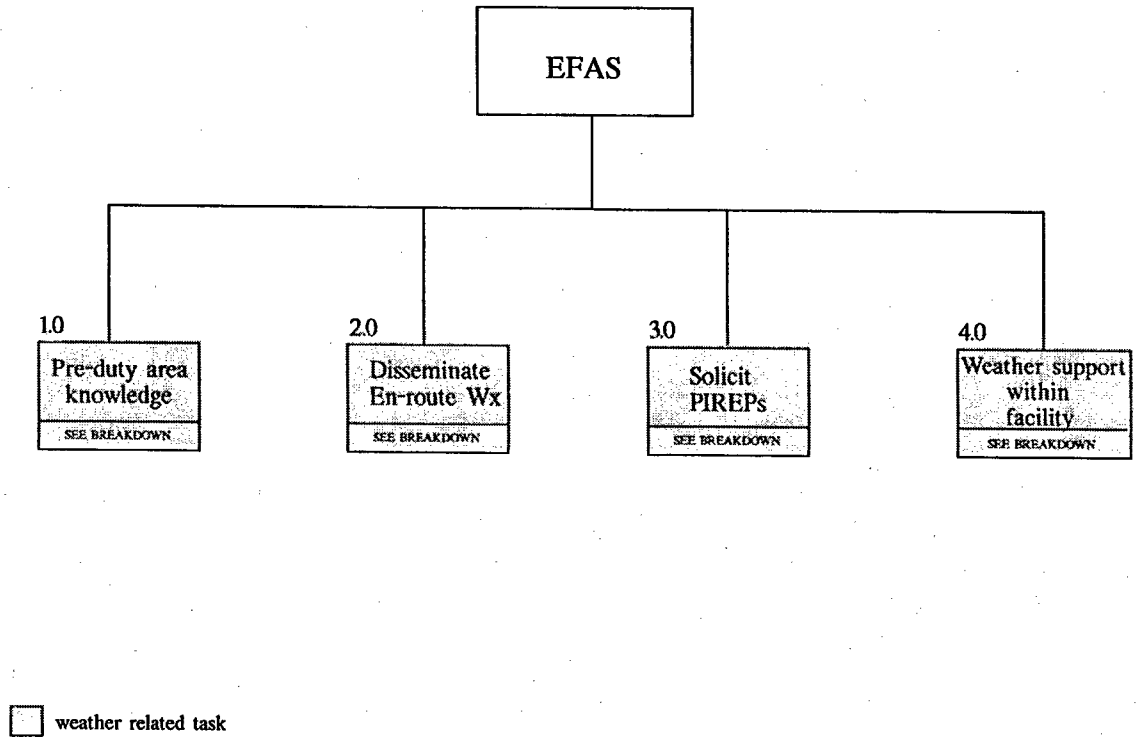
Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
Obtain wind direction and speed	Provide pilot with airport weather	Direct read (instrument)		Text	Provide info for current traffic flow
Determine favored runway	Provide pilot with airport info	Direct read from wind instrument		Text	Provide info for current traffic flow
Determine altimeter setting	Provide pilot with info	Direct read (instrument) M1FC		Text	Provide info for current traffic flow
Obtain weather	Provide pilot with airport weather	M1FC	Use terminal forecast to obtain wx	Text	Provide info for current traffic flow
Obtain ceiling and visibility	Provide pilot with airport weather	M1FC	Use SA to obtain ceiling and visibility	Text	Provide info for current traffic flow
Obtain RVR/RVV	Provide pilot with runway visibility	Direct read (instrument)		Text	Issued to IFR traffic for approach mins

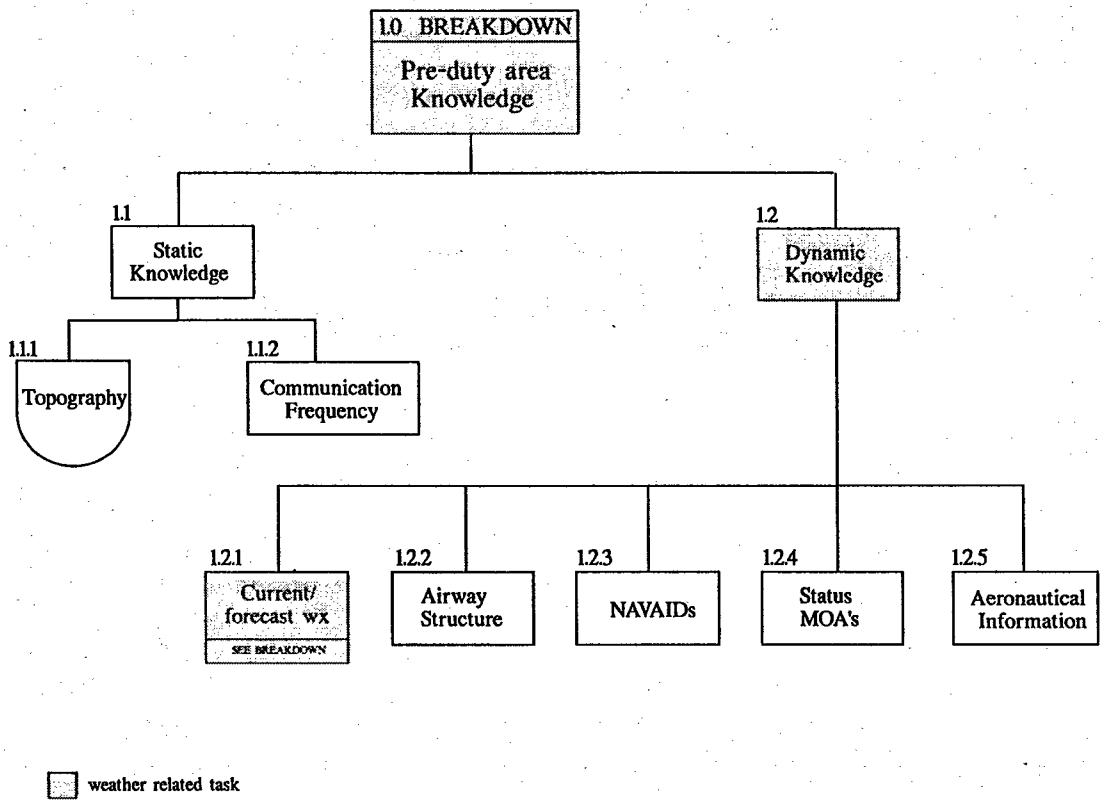
8.1.1/8.2.1 Obtain Weather Information

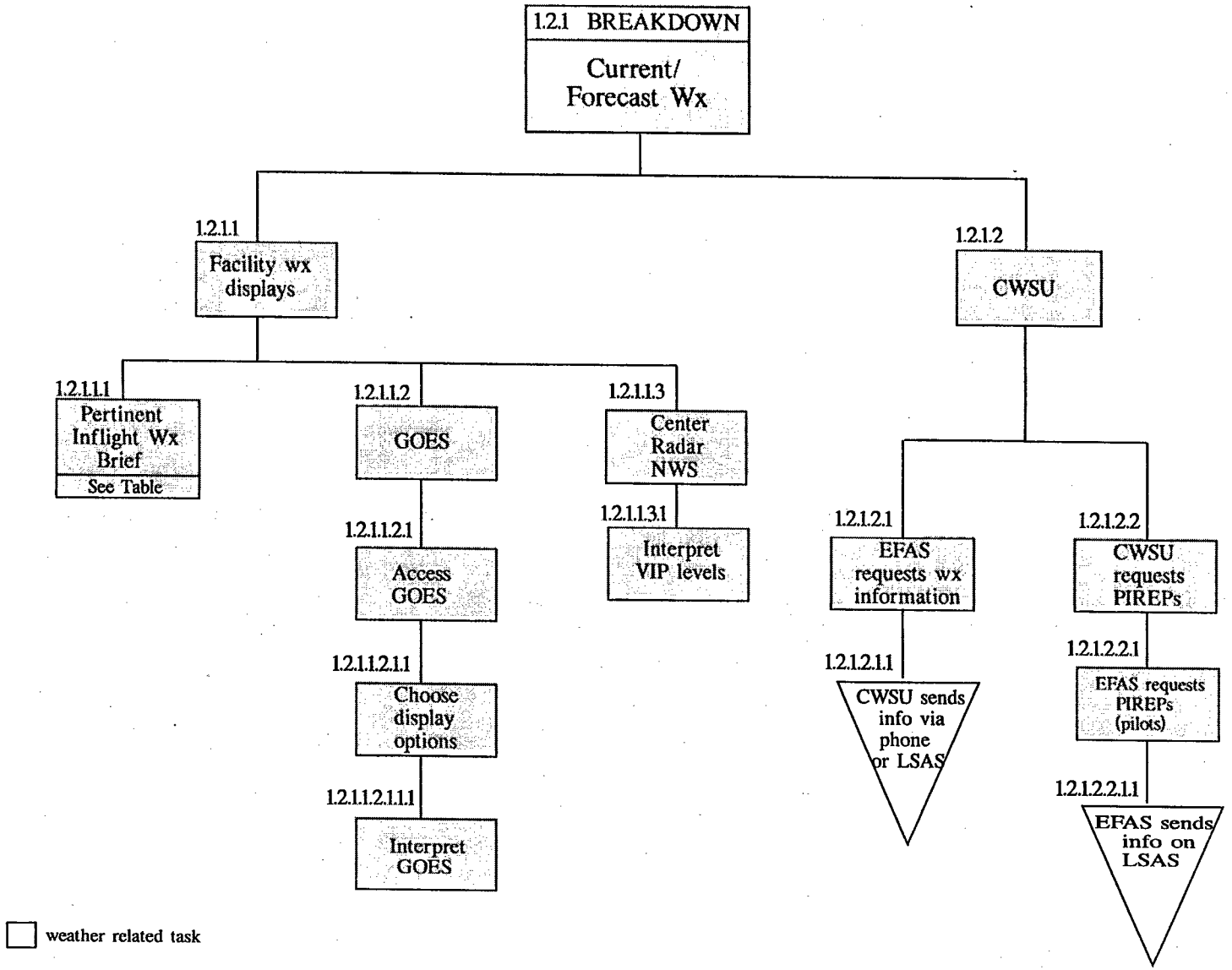
Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
Obtain hazardous weather	Provide pilot with weather info	M1FC		Text	Issue new hazardous wx
Obtain wake turbulence	Provide pilot with runway turbulence	Info based on type of arcft on rnwy prior		Verbal	Issue if wake turbc is a factor


9.0 BREAKDOWN
Emergency
9.1
Information required by inflight
9.2
Aircraft orientation info. required by inflight

EFAS Specialists JTA


EFAS
1.0
Pre-duty area knowledge
SEE BREAKDOWN
2.0
Disseminate En-route Wx
SEE BREAKDOWN
3.0
Solicit PIREPs
SEE BREAKDOWN
4.0
Weather support within facility
SEE BREAKDOWN
weather related task


1.0 BREAKDOWN
Pre-duty area Knowledge
1.1
Static Knowledge
1.2
Dynamic Knowledge
1.1.1
Topography
1.1.2
Communication Frequency
1.2.1
Current/ forecast wx
SEE BREAKDOWN
1.2.2
Airway Structure
1.2.3
NAVAIDs
1.2.4
Status MOA's
1.2.5
Aeronautical Information
weather related task


1.2.1 BREAKDOWN
Current/ Forecast Wx
1.2.1.1
Facility wx displays
1.2.1.2
CWSU
1.2.1.1.1
Pertinent Inflight Wx Brief
See Table
1.2.1.1.2
GOES
1.2.1.1.3
Center Radar NWS
1.2.1.1.2.1
Access GOES
1.2.1.1.3.1
Interpret VIP levels
1.2.1.1.2.1.1
Choose display options
1.2.1.1.2.1.1.1
Interpret GOES
1.2.1.2.1
EFAS requests wx information
1.2.1.2.2
CWSU requests PIREPs
1.2.1.2.1.1
CWSU sends info via phone or LSAS
1.2.1.2.2.1
EFAS requests PIREPs (pilots)
1.2.1.2.2.1.1
EFAS sends info on LSAS
weather related task

1.2.1.1.1 Pertinent Inflight Wx Brief

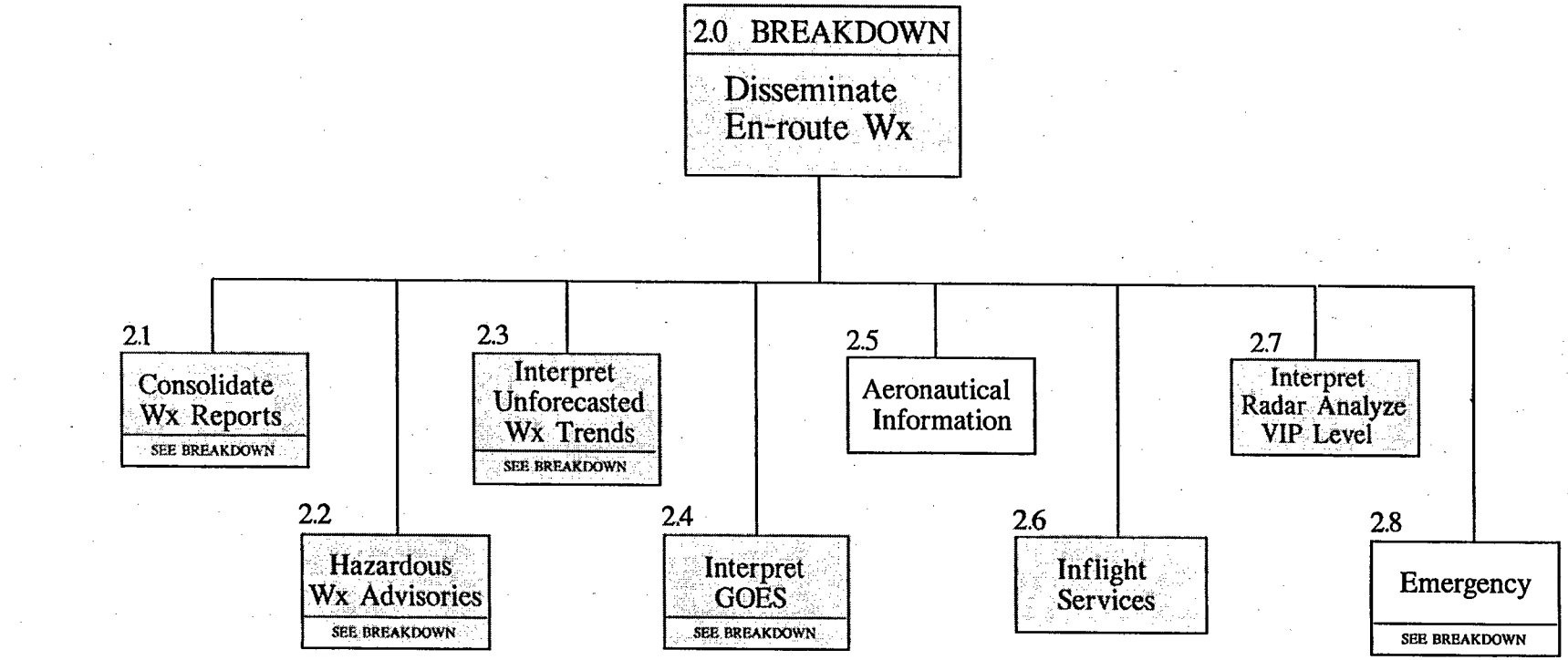
Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
Obtain adverse wx conditions	Perform self brief	M1FC and vendor graphic wx		Text and graphics	May cause pilot to change flight plan
Obtain LLWAS	Check for approach and departure	M1FC	Confirm using PIREPs	Text	Light aircraft may be affected by LLWAS
Obtain thunder-Storms	Check for hazardous wx	M1FC, radar, and vendor graphic wx		Text and graphics	May cause change in flight plan
Obtain icing and turbulence	Check for hazardous wx	M1FC and facility graphic wx	Confirm with PIREPs/verify intensity	Text and graphics	May make change in altitude necessary
Obtain weather Advisories	Check for hazardous wx	M1FC and facility graphic wx	Confirm with radar and PIREPs	Text and graphics	May cause change in flight plan
Obtain weather depiction	Look for areas of VFR/IFR	M1FC and vendor graphic wx	Confirm using GOES and SA	Text and graphics	Look for IFR cond./alternate airport

1.2.1.1.1 Pertinent Inflight Wx Brief (Continued)

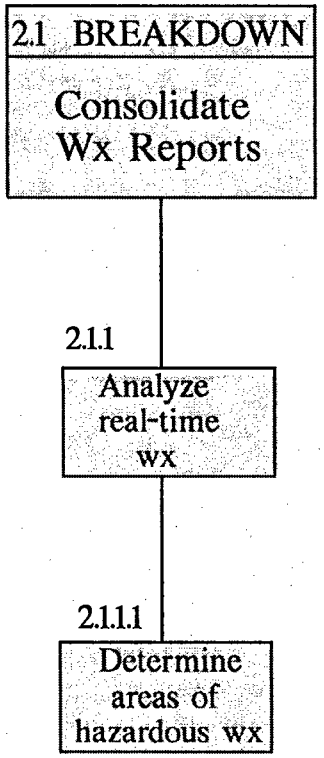
Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
Obtain synopsis	Provide locn and mvmt of wx systems	M1FC and vendor graphic wx	Compare to satellite imagery	Text and graphics	Check for new location of frontal zones
Obtain terminal forecast	Provide terminal area wx	M1FC	Compare to SA conditions and radar	Text	Update any changes since departure time
Obtain current conditions	Summarize SA, PIREPs, and RAREPs	M1FC	Confirm using M1FC, PIREPs, and GOES	Text	Change in cond. May change flight plan
Obtain satellite imagery	Used to verify wx information	Vendor graphic wx	Compare to surface chart, SA, prog chart	Graphics	Aids in monitoring cloud movement
Obtain en-route wx forecast	Provide forecast along route	M1FC and vendor graphic wx	Comparing text and graphic information	Text and graphics	Wx info needed for en route and descent
Obtain area forecast	Provide forecast along route	M1FC	Compare wx from M1FC to radar and GOES	Text	Summary of forecast for area weather

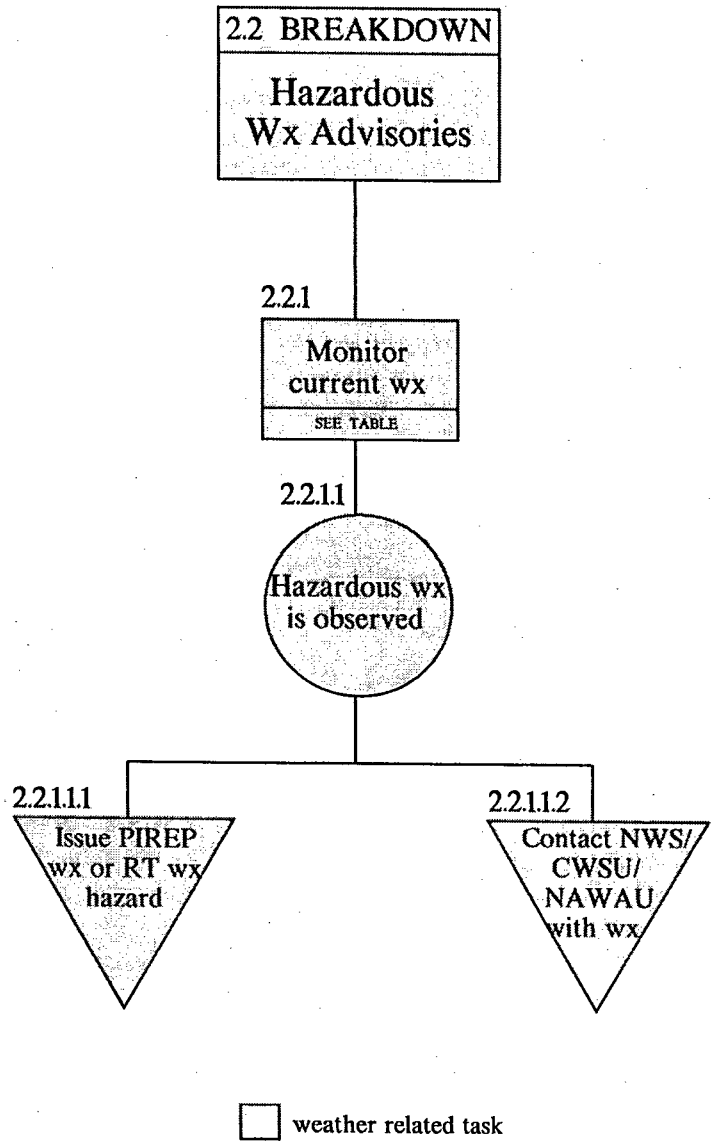
1.2.1.1.1 Pertinent Inflight Wx Brief (Continued)

Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
View prognosis Charts	Provide forecast along route	Vendor graphic wx		Graphics	Aids in noting deviations btwn FA and FT
Obtain winds aloft	Provide wind speed and dir	M1FC and vendor graphic wx	Interpolate winds from M1FC btwn alt.	Text and graphics	Provides best altitude for route of flight
Obtain upper air moisture	Provides frzglvl, RH, K index	Vendor graphic wx	Compare to RADAT readings from M1FC	Graphic	May cause change in flight plan
Obtain PIREPs	Request for pilot reports	Radio request and M1FC	Used to confirm M1FC and vendor wx	Verbal info and text	Verifies any unforecasted wx conditions



weather related task


2.1 BREAKDOWN
Consolidate Wx Reports
2.1.1
Analyze real-time wx
2.1.1.1
Determine areas of hazardous wx
weather related task

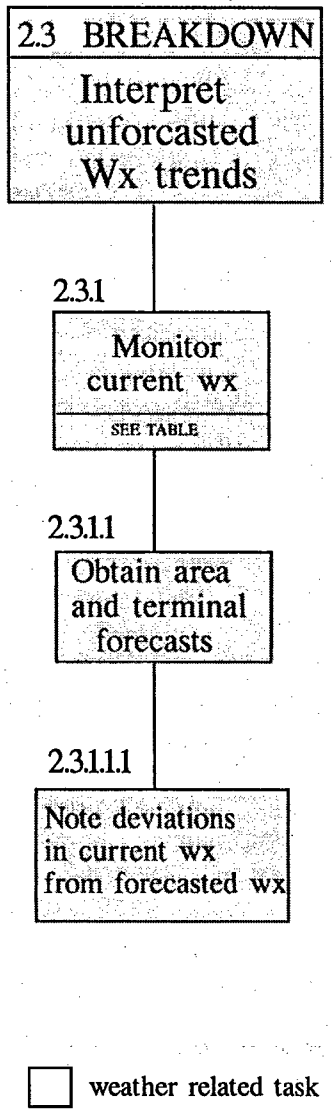

2.2 BREAKDOWN
Hazardous Wx Advisories
2.2.1
Monitor current wx
SEE TABLE
2.2.1.1
Hazardous wx is observed
2.2.1.1.1
Issue PIREP wx or RT wx hazard
2.2.1.1.2
Contact NWS/ CWSU/ NAWAU with wx
weather related task

2.2.1 Monitor Current Weather

Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
Obtain adverse wx conditions	Perform self brief	M1FC and vendor graphic wx		Text and graphics	Monitor changing wx
Obtain LLWAS	Check for Approach and Departure	M1FC	Confirm with PIREPs	Text	Monitor changing wind shear
Obtain thunder-Storms	Check for Hazardous wx	M1FC, radar, and vendor graphic wx		Text and graphics	Monitor for change or new advisories
Obtain icing	Check for Hazardous wx	M1FC and facility graphic wx	Confirm with PIREPs/verify intensities	Text and graphics	Monitor for change or new advisories
Obtain weather Advisories	Check for Hazardous wx	M1FC and vendor graphic wx	Confirm with radar and PIREPs	Text and graphics	Monitor for new advisories issued
Obtain weather depiction	Look for areas of VFR/IFR	M1FC and vendor graphic wx	Confirm using GOES and SA	Text and graphics	Monitor IFR/VFR conditions
Obtain synopsis	Provide locn and mvmt of wx system	M1FC and vendor graphic wx	Compare to satellite imagery	Text and graphics	Monitor movement of wx systems

2.2.1 Monitor Current Weather (Continued)

Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
Obtain satellite imagery	Used to verify wx information	Vendor graphic wx	Compare to surface chart, SA, prog chart	Graphics	Monitor cloud coverage/ frontal mvmt.
Obtain current conditions	Summarize SAs, PIREPs, and RAREPs	M1FC	Confirm using M1FC, PIREPs, and GOES	Text	Monitor surface observations
Obtain en-route wx forecast	Provide forecast along route	M1FC and vendor graphic wx	Compare text and graphic wx information	Text and graphics	Monitor wx along common routes
Obtain area forecast	Provide forecast along route	M1FC	Compare wx from M1FC to radar and GOES	Text	Monitor FA for changes in forecast
View prognosis Charts	Provide forecast along route	Vendor graphic wx		Graphics	
Obtain winds aloft	Provide wind speed and direction	M1FC and vendor graphic wx	Interpolate winds from M1FC btwn alt.	Text and graphics	Monitor winds for changes aloft
Obtain PIREPs	Request for pilot reports	Radio request and M1FC	Used to confirm M1FC and vendor wx	Verbal info and text	Monitor PIREPs to confirm current wx

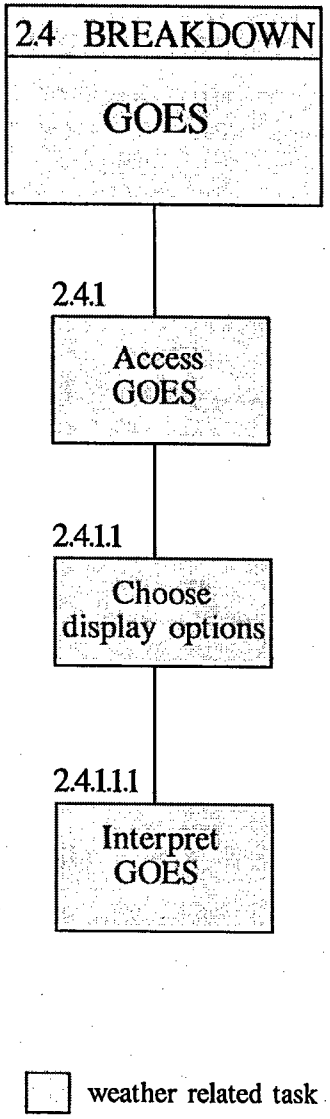

2.3 BREAKDOWN
Interpret unforcasted Wx trends
2.3.1
Monitor current wx
SEE TABLE
2.3.1.1
Obtain area and terminal forecasts
2.3.1.1.1
Note deviations in current wx from forecasted wx
weather related task

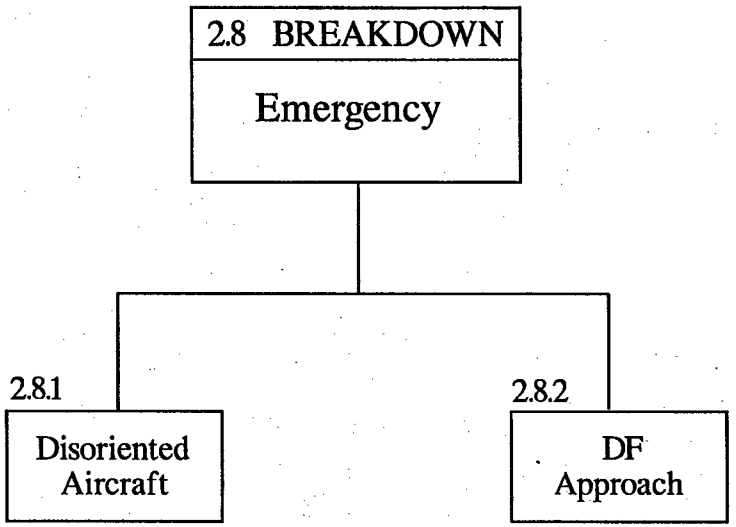
2.3.1 Monitor Current Weather

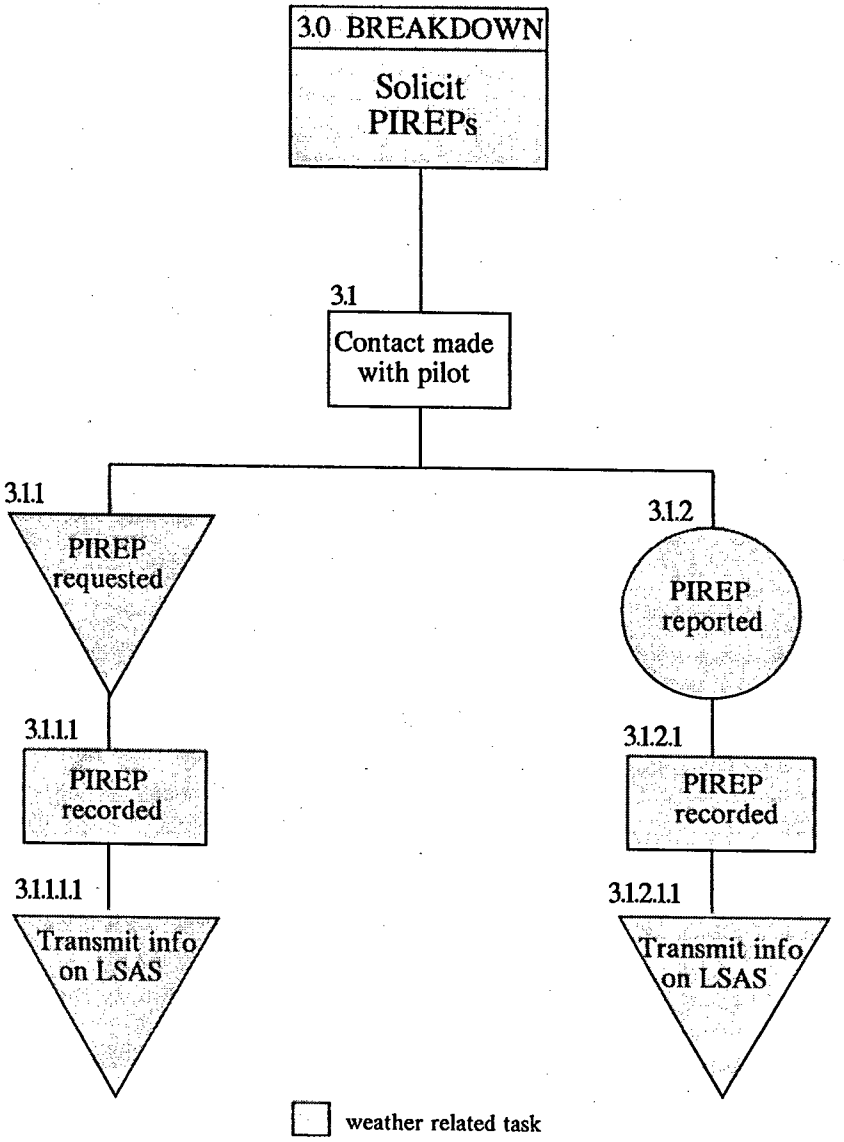
Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
Obtain adverse wx conditions	Perform self brief	M1FC and vendor graphic wx		Text and graphics	Monitor changing wx
Obtain LLWAS	Check for approach and departure	M1FC	Confirm with PIREPs	Text	Monitor changing wind shear
Obtain thunder-Storms	Check for hazardous wx	M1FC, radar, and vendor graphic wx		Text and graphics	Monitor for change or new advisories
Obtain icing	Check for hazardous wx	M1FC and facility graphic wx	Confirm with PIREPs/verify intensities	Text and graphics	Monitor for change or new advisories
Obtain weather Advisories	Check for hazardous wx	M1FC and vendor graphic wx	Confirm with radar and PIREPs	Text and graphics	Monitor for new advisories issued
Obtain weather depiction	Look for areas of VFR/IFR	M1FC and vendor graphic wx	Confirm using GOES and SA	Text and graphics	Monitor IFR/VFR conditions
Obtain synopsis	Provide locn and mvmt of wx system	M1FC and vendor graphic wx	Compare to satellite imagery	Text and graphics	Monitor movement of wx systems

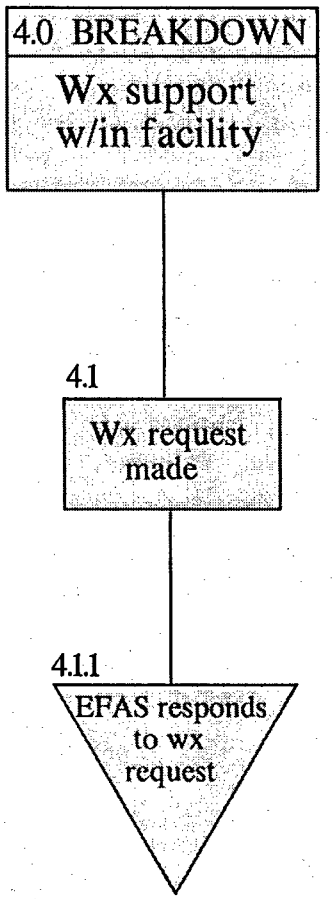
2.3.1 Monitor Current Weather (Continued)

Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
Obtain satellite imagery	Used to verify wx information	Vendor graphic wx	Compare to surface chart, SA, prog chart	Graphics	Monitor cloud coverage/ frontal mvmt.
Obtain current conditions	Summarize SAs, PIREPs, and RAREPs	M1FC	Confirm using M1FC, PIREPs, and GOES	Text	Monitor surface observations
Obtain en-route wx forecast	Provide forecast along route	M1FC and vendor graphic wx	Compare text and graphic wx information	Text and graphics	Monitor wx along common routes
Obtain area forecast	Provide forecast along route	M1FC	Compare wx from M1FC to radar and GOES	Text	Monitor FA for changes in forecast
View prognosis charts	Provide forecast along route	Vendor graphic wx		Graphics	
Obtain winds aloft	Provide wind speed and direction	M1FC and vendor graphic wx	Interpolate winds from M1FC btwn alt.	Text and graphics	Monitor winds for changes aloft
Obtain PIREPs	Request for pilot reports	Radio request and M1FC	Used to confirm M1FC and vendor wx	Verbal info and text	Monitor PIREPs to confirm current wx


2.4 BREAKDOWN
GOES
2.4.1
Access GOES
2.4.1.1
Choose display options
2.4.1.1.1
Interpret GOES
weather related task

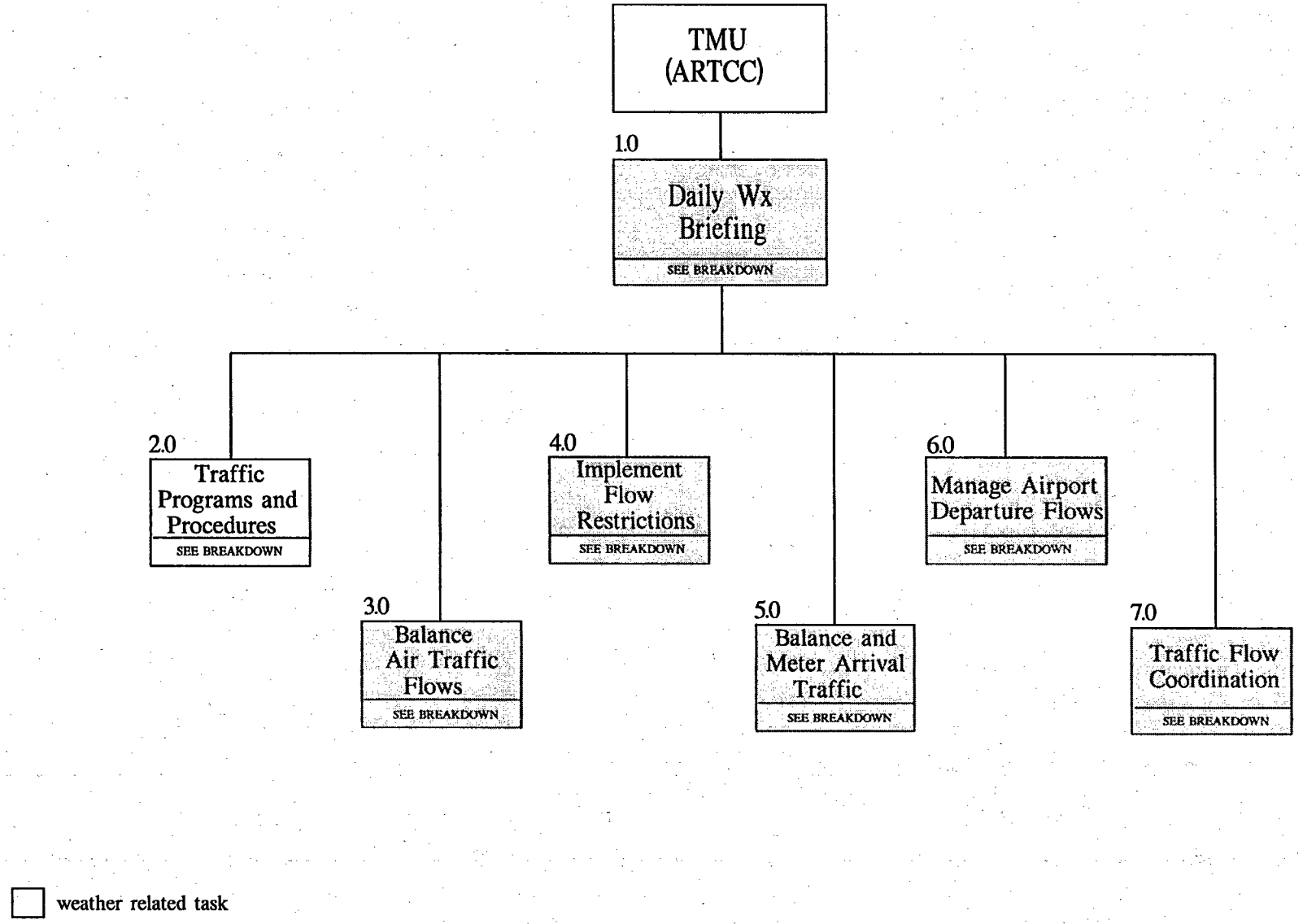

2.8 BREAKDOWN
Emergency
2.8.1
Disoriented Aircraft
2.8.2
DF Approach


3.0 BREAKDOWN
Solicit PIREPs
3.1
Contact made with pilot
3.1.1
PIREP requested
3.1.1.1
PIREP recorded
3.1.1.1.1
Transmit info on LSAS
3.1.2
PIREP reported
3.1.2.1
PIREP recorded
3.1.2.1.1
Transmit info on LSAS
weather related task



weather related task

ARTCC TMC Coordinator JTA

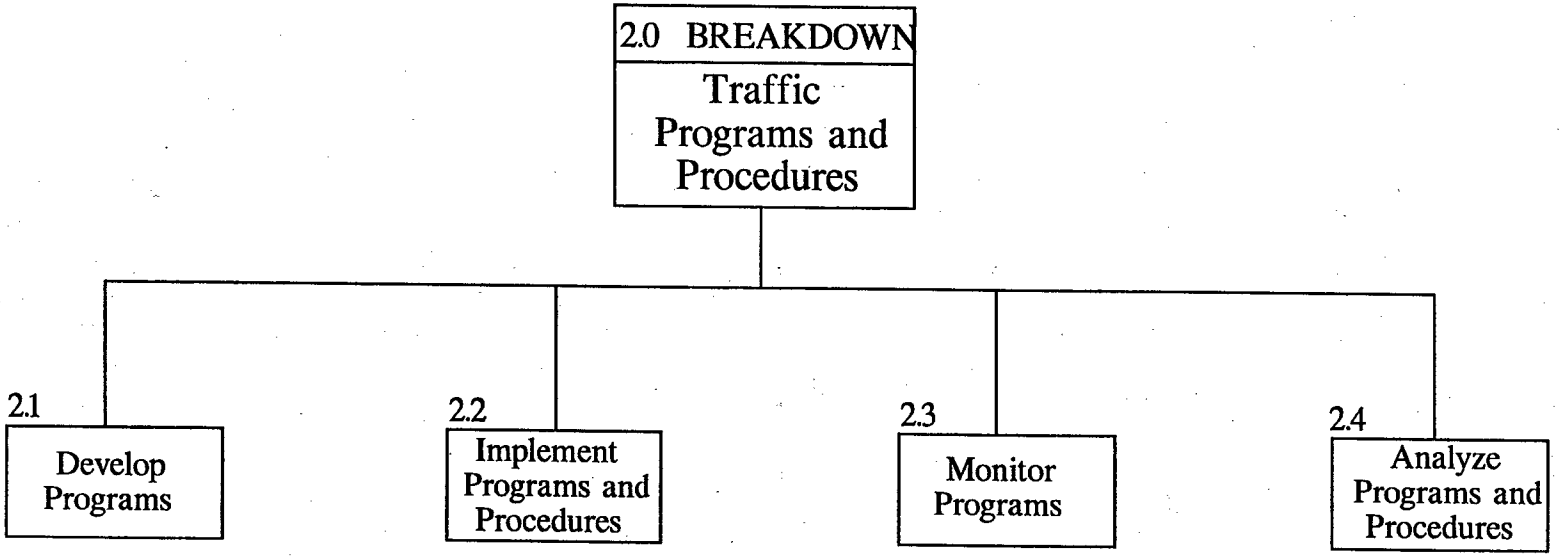

TMU
(ARTCC)
1.0
Daily Wx
Briefing
SEE BREAKDOWN
2.0
Traffic
Programs and
Procedures
SEE BREAKDOWN
3.0
Balance
Air Traffic
Flows
SEE BREAKDOWN
4.0
Implement
Flow
Restrictions
SEE BREAKDOWN
5.0
Balance and
Meter Arrival
Traffic
SEE BREAKDOWN
6.0
Manage Airport
Departure Flows
SEE BREAKDOWN
7.0
Traffic Flow
Coordination
SEE BREAKDOWN
weather related task

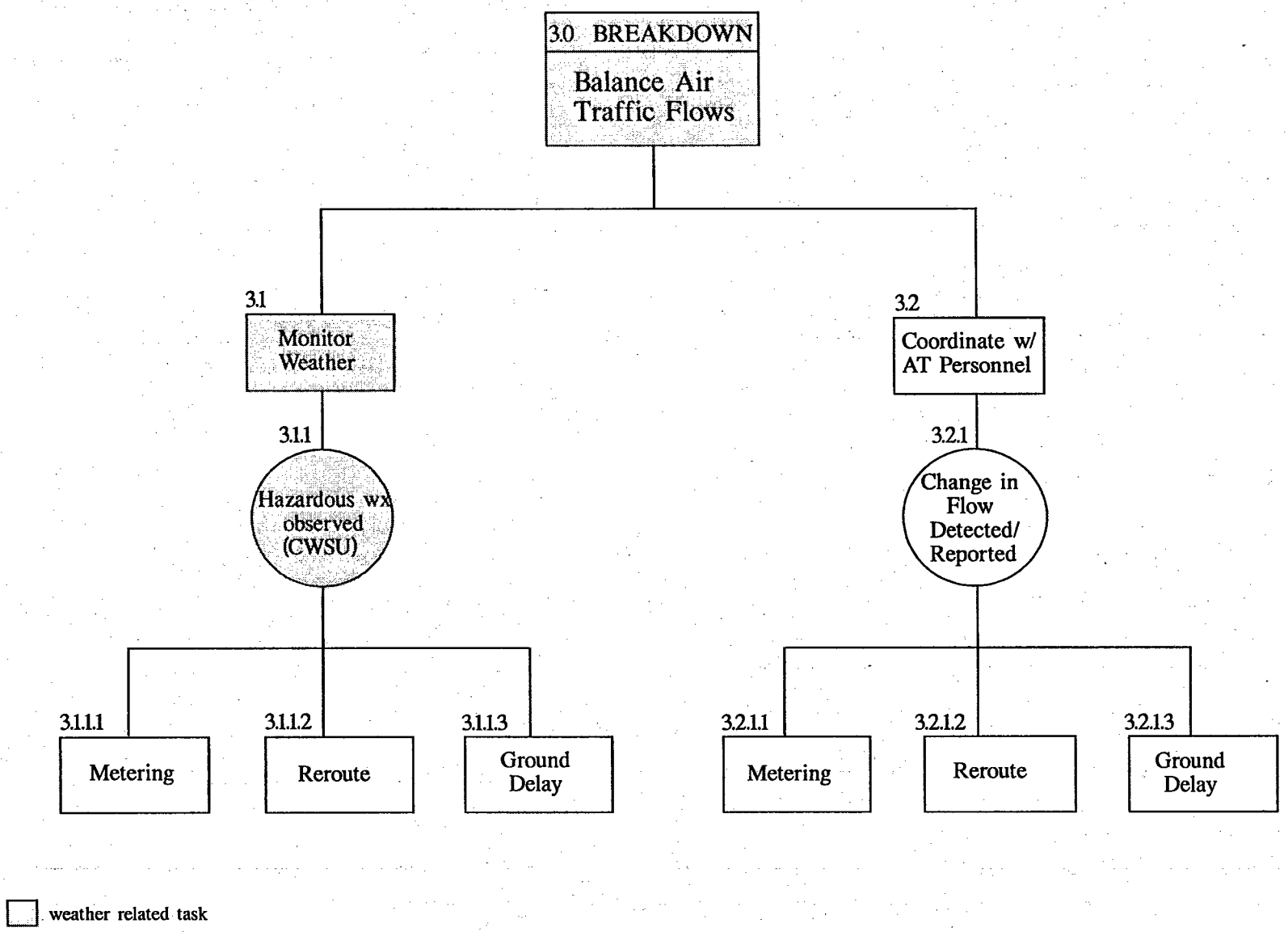
1.0 Daily Weather Briefing

Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
View convective activity	To watch for convective activity	MWP		Graphics	Reroute and balance AT flow
Obtain ceilings and visibility	To note areas of cloud coverage	MWP		Graphics	Metering / flow restriction
Obtain icing	To note areas of icing	CWSU/PIREPs		Text and briefing (verbal info)	
Obtain lightning	To note areas of hazardous wx	ASD, NEXRAD		Graphics	
Obtain precip.	To watch for areas of hazardous wx	Radar, ASD, MWP, NEXRAD		Graphics/text	
Obtain surface wind	Obtain wind information	KBVT host/ASD		Text	Implement flow restriction
Obtain turbulence	Obtain turb. information	CWSU/PIREPs		Text and briefing (verbal info)	

1.0 Daily Weather Briefing (Continued)

Task Elements	Purpose	Information Source	User Interpretation	Information Format	Usability
Obtain jet stream	View jet stream information	CWSU/ASD		Text and briefing (verbal info)	Implement flow restriction
Obtain microbursts	Obtain hazardous wx information	CWSU		Text and briefing (verbal info)	Reroute traffic
Obtain volcanic ash	Obtain wx information	CWSU		Text and briefing (verbal info)	Reroute traffic
Obtain mountain wave	Obtain hazardous wx information	CWSU		Text and briefing (verbal info)	Reroute traffic


2.0 BREAKDOWN
Traffic Programs and Procedures
2.1
Develop Programs
2.2
Implement Programs and Procedures
2.3
Monitor Programs
2.4
Analyze Programs and Procedures

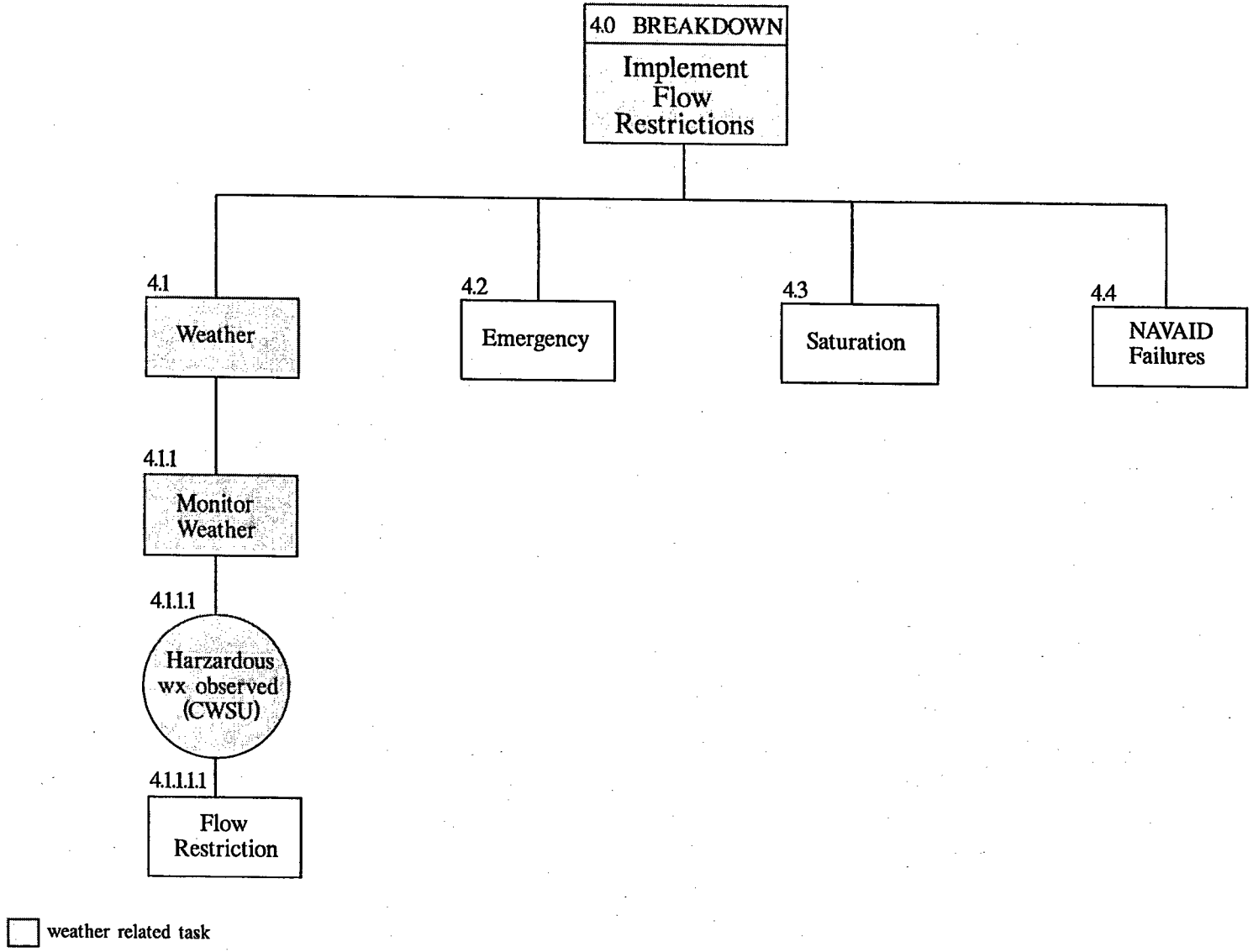

3.0 BREAKDOWN
Balance Air Traffic Flows
3.1
Monitor Weather
3.2
Coordinate w/ AT Personnel
3.1.1
Hazardous wx observed (CWSU)
3.2.1
Change in Flow Detected/ Reported
3.1.1.1
Metering
3.1.1.2
Reroute
3.1.1.3
Ground Delay
3.2.1.1
Metering
3.2.1.2
Reroute
3.2.1.3
Ground Delay
weather related task

3.1 Monitor Weather

Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
View convective activity	To watch for convective activity	MWP		Graphics	Reroute and balance AT flow
Obtain ceilings and visibility	To note areas of cloud coverage	MWP		Graphics	Metering / flow restriction
Obtain icing	To note areas of icing	CWSU/PIREPs		Text and briefing (verbal info)	
Obtain lightning	To note areas of hazardous wx	ASD, NEXRAD		Graphics	
Obtain precip.	To watch for areas of hazardous wx	Radar, ASD, MWP, NEXRAD		Graphics/text	
Obtain surface wind	Obtain wind information	KBVT host/ASD		Text	Implement flow restriction
Obtain turbulence	Obtain turb. information	CWSU/PIREPs		Text and briefing (verbal info)	

3.1 Monitor Weather (Continued)

Task Elements	Purpose	Information Source	User Interpretation	Information Format	Usability
Obtain jet stream	View jet stream information	CWSU/ASD		Text and briefing (verbal info)	Implement flow restriction
Obtain microbursts	Obtain hazardous wx information	CWSU		Text and briefing (verbal info)	Reroute traffic
Obtain volcanic ash	Obtain wx information	CWSU		Text and briefing (verbal info)	Reroute traffic
Obtain mountain wave	Obtain hazardous wx information	CWSU		Text and briefing (verbal info)	Reroute traffic

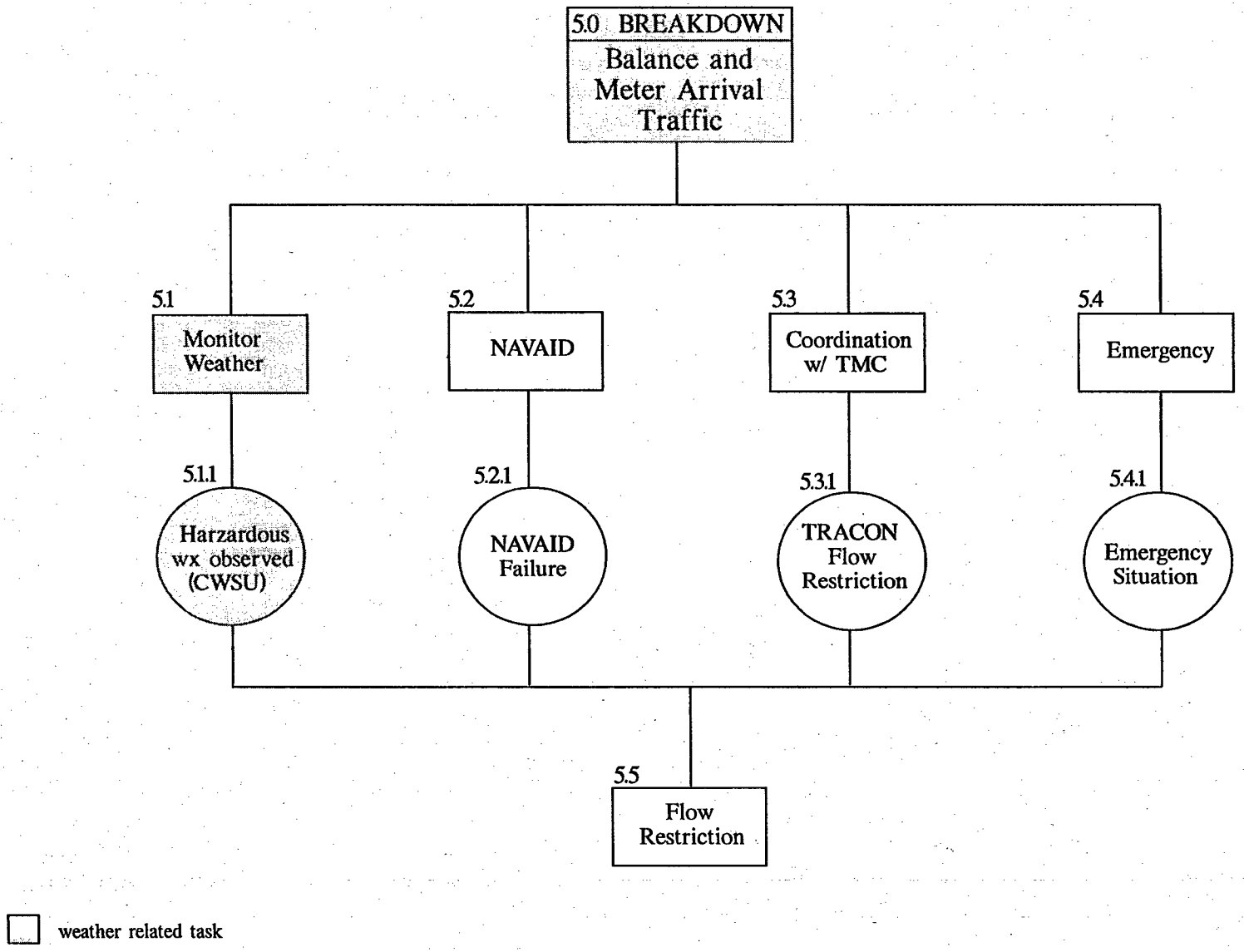

4.0 BREAKDOWN
Implement Flow Restrictions
4.1
Weather
4.2
Emergency
4.3
Saturation
4.4
NAVAID Failures
4.1.1
Monitor Weather
4.1.1.1
Harzardous wx observed (CWSU)
4.1.1.1.1
Flow Restriction
weather related task

4.1.1 Monitor Weather

Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
View convective activity	To watch for convective activity	MWP		Graphics	Reroute and balance AT flow
Obtain ceilings and visibility	To note areas of cloud coverage	MWP		Graphics	Metering / flow restriction
Obtain icing	To note areas of icing	CWSU/PIREPs		Text and briefing (verbal info)	
Obtain lightning	To note areas of hazardous wx	ASD, NEXRAD		Graphics	
Obtain precip.	To watch for areas of hazardous wx	Radar, ASD, MWP, NEXRAD		Graphics/text	
Obtain surface wind	Obtain wind information	KBVT host/ASD		Text	Implement flow restriction
Obtain turbulence	Obtain turb. information	CWSU/PIREPs		Text and briefing (verbal info)	

4.1.1 Monitor Weather (Continued)

Task Elements	Purpose	Information Source	User Interpretation	Information Format	Usability
Obtain jet stream	View jet stream Information	CWSU/ASD		Text and briefing (verbal info)	Implement flow restriction
Obtain microbursts	Obtain hazardous wx information	CWSU		Text and briefing (verbal info)	Reroute traffic
Obtain volcanic ash	Obtain wx information	CWSU		Text and briefing (verbal info)	Reroute traffic
Obtain mountain wave	Obtain hazardous wx information	CWSU		Text and briefing (verbal info)	Reroute traffic

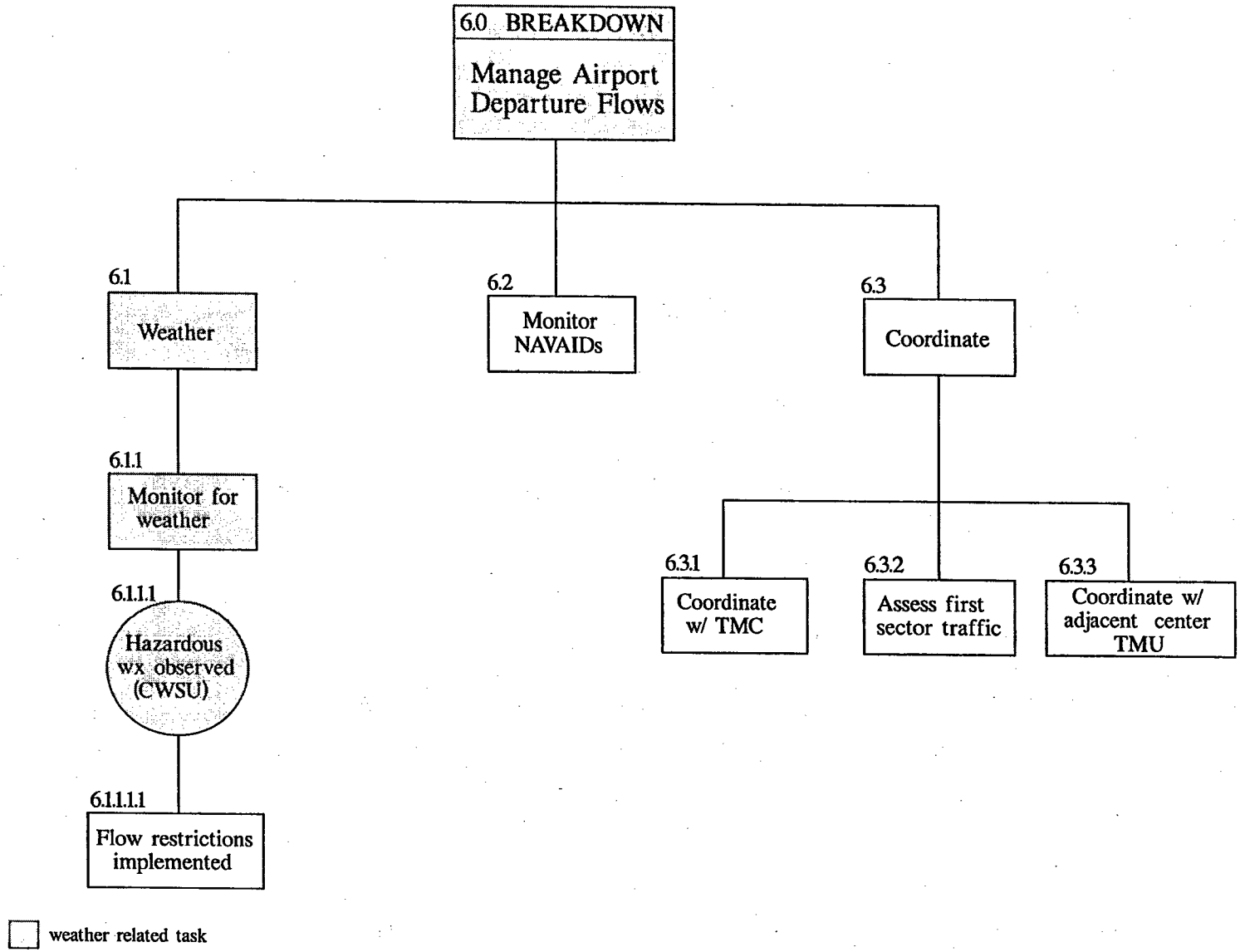

5.0 BREAKDOWN
Balance and Meter Arrival Traffic
5.1
Monitor Weather
5.2
NAVAID
5.3
Coordination w/ TMC
5.4
Emergency
5.1.1
Harzardous wx observed (CWSU)
5.2.1
NAVAID Failure
5.3.1
TRACON Flow Restriction
5.4.1
Emergency Situation
5.5
Flow Restriction
weather related task

5.1 Monitor Weather

Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
View convective activity	To watch for convective activity	MWP		Graphics	Reroute and balance AT flow
Obtain ceilings and visibility	To note areas of cloud coverage	MWP		Graphics	Metering / flow restriction
Obtain icing	To note areas of icing	CWSU/PIREPs		Text and briefing (verbal info)	
Obtain lightning	To note areas of hazardous wx	ASD, NEXRAD		Graphics	
Obtain precip.	To watch for areas of hazardous wx	Radar, ASD, MWP, NEXRAD		Graphics/text	
Obtain surface wind	Obtain wind information	KBVT host/ASD		Text	Implement flow restriction
Obtain turbulence	Obtain turb. information	CWSU/PIREPs		Text and briefing (verbal info)	

5.1 Monitor Weather (Continued)

Task Elements	Purpose	Information Source	User Interpretation	Information Format	Usability
Obtain jet stream	View jet stream Information	CWSU/ASD		Text and briefing (verbal info)	Implement flow restriction
Obtain microbursts	Obtain hazardous wx information	CWSU		Text and briefing (verbal info)	Reroute traffic
Obtain volcanic ash	Obtain wx information	CWSU		Text and briefing (verbal info)	Reroute traffic
Obtain mountain wave	Obtain hazardous wx information	CWSU		Text and briefing (verbal info)	Reroute traffic

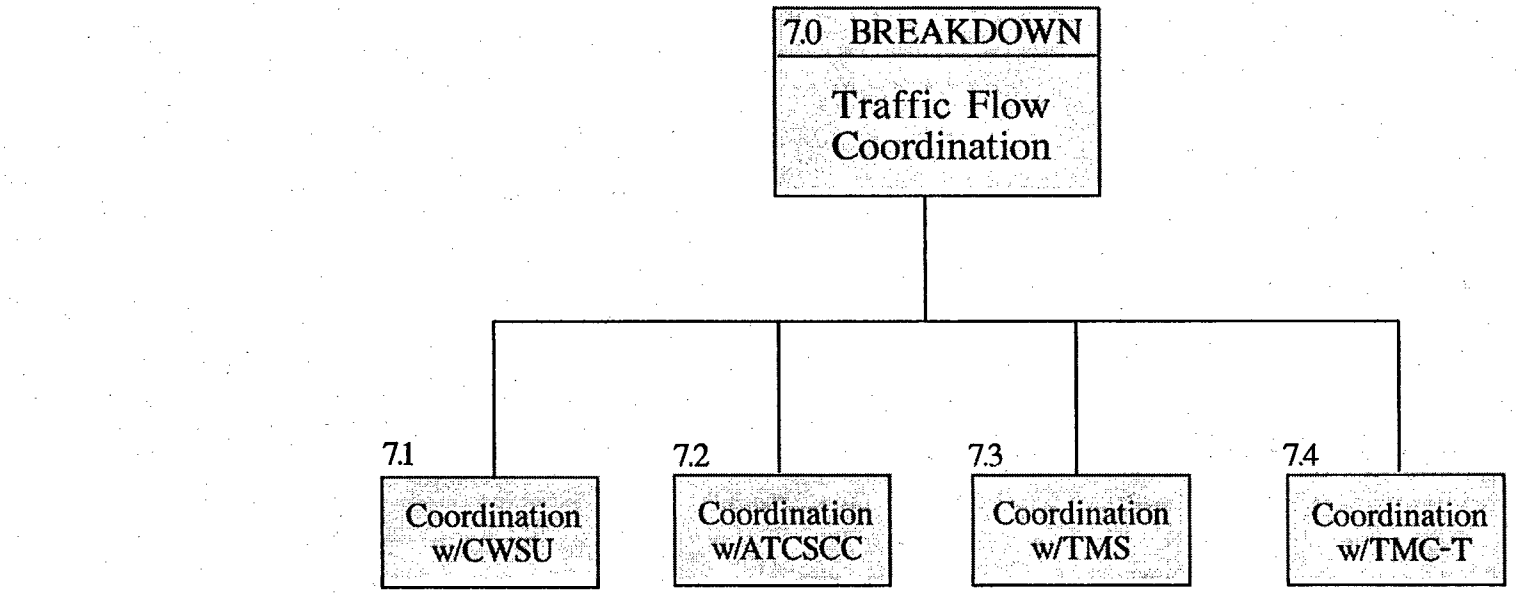

6.0 BREAKDOWN
Manage Airport Departure Flows
6.1
Weather
6.2
Monitor NAVAIDs
6.3
Coordinate
6.1.1
Monitor for weather
6.1.1.1
Hazardous wx observed (CWSU)
6.1.1.1.1
Flow restrictions implemented
6.3.1
Coordinate w/ TMC
6.3.2
Assess first sector traffic
6.3.3
Coordinate w/ adjacent center TMU
weather related task

6.1.1 Monitor Weather

Task Elements	Purpose	Information Source	User Interpretation	Information Format	Utility
View convective activity	To watch for convective activity	MWP		Graphics	Reroute and balance AT flow
Obtain ceilings and visibility	To note areas of cloud coverage	MWP		Graphics	Metering / flow restriction
Obtain icing	To note areas of icing	CWSU/PIREPs		Text and briefing (verbal info)	
Obtain lightning	To note areas of hazardous wx	ASD, NEXRAD		Graphics	
Obtain precip.	To watch for areas of hazardous wx	Radar, ASD, MWP, NEXRAD		Graphics/text	
Obtain surface wind	Obtain wind information	KBVT host/ASD		Text	Implement flow restriction
Obtain turbulence	Obtain turb. information	CWSU/PIREPs		Text and briefing (verbal info)	

6.1.1 Monitor Weather (Continued)

Task Elements	Purpose	Information Source	User Interpretation	Information Format	Usability
Obtain jet stream	View jet stream information	CWSU/ASD		Text and briefing (verbal info)	Implement flow restriction
Obtain microbursts	Obtain hazardous wx information	CWSU		Text and briefing (verbal info)	Reroute traffic
Obtain volcanic ash	Obtain wx information	CWSU		Text and briefing (verbal info)	Reroute traffic
Obtain mountain wave	Obtain hazardous wx information	CWSU		Text and briefing (verbal info)	Reroute traffic



weather related task